First Session—Twenty-eighth Parliament

1968-69

THE SENATE OF CANADA

PROCEEDINGS
OF THE
SPECIAL COMMITTEE
ON

SCIENCE POLICY

The Honourable MAURICE LAMONTAGNE, P.C., *Chairman*

The Honourable DONALD CAMERON, *Vice-Chairman*

No. 71 - 80

TUESDAY, JUNE 24th, 1969

WITNESSES:

Dominion Foundries and Steel: Mr. Alan D. Laing, Assistant to Executive Vice-President (Financial), Mr. Noel Thomas, Manager of Research and Development; Steel Company of Canada Limited: Mr. A. D. Fisher, Vice-President, Planning, Engineering and Research Division, Mr. W. A. Darby, Tax Accountant, Mr. J. C. McKay, General Supervisor of Research; Falconbridge Nickel Mines Limited; Mr. P. G. Thornhill, Director; Aluminum Company of Canada Ltd.: Mr. G. M. Mason, Technical Director, Mr. Gilbert Proulx, Manager, Public Relations (Research)

APPENDICES:

171—Brief submitted by Dominion Foundries and Steel Limited

172—Brief submitted by The Steel Company of Canada Limited

173—Brief submitted by Aluminum Company of Canada Ltd.

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MEMBERS OF THE SPECIAL COMMITTEE

ON

SCIENCE POLICY

The Honourable Maurice Lamontagne, *Chairman*

The Honourable Donald Cameron, *Vice-Chairman*

The Honourable Senators:

Aird	Grosart	Nichol
Belisle	Haig	O'Leary (*Carleton*)
Blois	Hays	Phillips (*Prince*)
Bourget	Kinnear	Robichaud
Cameron	Lamontagne	Sullivan
Carter	Lang	Thompson
Desruisseaux	Leonard	Yuzyk
Giguère	McGrand	

Patrick J. Savoie,
Clerk of the Committee.

ORDERS OF REFERENCE

Extract from the Minutes of the Proceedings of the Senate, Tuesday, September 17th, 1968:

"The Honourable Senator Lamontagne, P.C., moved, seconded by the Honourable Senator Benidickson, P.C.:

That a Special Committee of the Senate be appointed to consider and report on the science policy of the Federal Government with the object of appraising its priorities, its budget and its efficiency in the light of the experience of other industrialized countries and of the requirements of the new scientific age and, without restricting the generality of the foregoing, to inquire into and report upon the following:

(*a*) recent trends in research and development expenditures in Canada as compared with those in other industrialized countries;

(*b*) research and development activities carried out by the Federal Government in the fields of physical, life and human sciences;

(*c*) federal assistance to research and development activities carried out by individuals, universities, industry and other groups in the three scientific fields mentioned above; and

(*d*) the broad principles, the long-term financial requirements and the structural organization of a dynamic and efficient science policy for Canada.

That the Committee have power to engage the services of such counsel, staff and technical advisers as may be necessary for the purpose of the inquiry;

That the Committee have power to send for persons, papers and records, to examine witnesses, to report from time to time, to print such papers and evidence from day to day as may be ordered by the Committee, to sit during sittings and adjournments of the Senate, and to adjourn from place to place;

That the papers and evidence received and taken on the subject in the preceding session be referred to the Committee; and

That the Committee be composed of the Honourable Senators Aird, Argue, Belisle, Bourget, Cameron, Desruisseaux, Grosart, Hays, Kinnear, Lamontagne, Lang, Leonard, MacKenzie, O'Leary (*Carleton*), Phillips (*Prince*), Sullivan, Thompson and Yuzyk.

After debate, and—

The question being put on the motion, it was—

Resolved in the affirmative."

Extract from the Minutes of the Proceedings of the Senate, Thursday, September 19th, 1968:

"With leave of the Senate,

The Honourable Senator Lamontagne, P.C., moved, seconded by the Honourable Senator Benidickson, P.C.:

That the name of the Honourable Senator Robichaud be substituted for that of the Honourable Senator Argue on the list of Senators serving on the Special Committee on Science Policy.

The question being put on the motion, it was—

Resolved in the affirmative."

Extract from the Minutes of the Proceedings of the Senate, Wednesday, February 5th, 1969:

"With leave of the Senate,

The Honourable Senator McDonald moved, seconded by the Honourable Senator Macdonald (*Cape Breton*):

That the names of the Honourable Senators Blois, Carter, Giguère, Haig, McGrand and Nichol be added to the list of Senators serving on the Special Committee on Science Policy.

The question being put on the motion, it was—

Resolved in the affirmative."

ROBERT FORTIER,
Clerk of the Senate.

MINUTES OF PROCEEDINGS

TUESDAY, June 24, 1969.

Pursuant to adjournment and notice the Special Committee on Science Policy met this day at 10.00 a.m.

Present: The Honourable Senators Lamontagne (*Chairman*), Belisle, Blois, Bourget, Carter, Grosart, Haig, Kinnear, Robichaud and Yuzyk—10.

In attendance: Philip J. Pocock, Director of Research (*Physical Science*).

The following witnesses were heard:

DOMINION FOUNDRIES AND STEEL

Mr. Alan D. Laing, Assistant to Executive Vice-President (Financial)

Mr. Noel Thomas, Manager of Research and Development

STEEL COMPANY OF CANADA LIMITED

Mr. A. D. Fisher, Vice-President

Planning Engineering and Research Division

Mr. W. A. Darby, Tax Accountant

Mr. J. C. McKay, General Supervisor of Research

FALCONBRIDGE NICKEL MINES LIMITED

Mr. P. G. Thornhill, Director

ALUMINUM COMPANY OF CANADA LTD.

Mr. G. M. Mason, Technical Director

Mr. Gilbert Proulx, Manager

Public Relations (Research)

(*A curriculum vitae of each witness follows these Minutes*)

The following are printed as Appendices:

No. 171—Brief submitted by Dominion Foundries and Steel Limited
No. 172—Brief submitted by The Steel Company of Canada Limited
No. 173—Brief submitted by Aluminum Company of Canada Ltd.

At 12.30 p.m. the Committee adjourned to the call of the Chairman.

ATTEST:

Patrick J. Savoie,
Clerk of the Committee.

CURRICULUM VITAE

Darby, Willford A.: born March 6th, 1922. Degree: Bachelor of Commerce—1949 Queen's University C.A. 1952. Joined Steel Company of Canada, Accounting Division on August 1st, 1955—appointed Tax Accountant October 21, 1959.

Fisher, A. D. was born in Calgary, Alberta on February 24, 1915: Graduated in 1937 in the University of Toronto with a B.A.Sc. Degree in Chemical Engineering. Commenced with Steel Company of Canada Limited in 1937 as a Metallurgist and advanced to the position of Superintendent—Coke Plant in 1943; General Superintendent—Hilton Works in 1951; Manager of Facilities Planning in 1963 and Vice-President, Planning Engineering and Research Division—1966.

Proulx, Gilbert, B.A.Sc., B.Eng. Consultant for special projects with the Aluminum Company of Canada Limited. Since 1942 has held various positions including that of Administrator of the $150,000,000 Chute-des-Passes Hydro Electric project in Northern Quebec and that of Vice-President, Operations, of an affiliated company. Member of several professional and social organizations.

Laing, Alan D.: born Winnipeg Manitoba. Graduated University of Manitoba with B. Comm, C.A. Degrees. Has position as Ontario Assistant to Executive Vice-President, Financial, Dominion Foundries and Steel Company.

Mason, George M., B.A.Sc.: Chemical Engineer and Technical Director with the Aluminum Company of Canada Limited since 1957. Previous to this has held various technical positions at Arvida works and that of General Purchasing Agent since joining the company in 1939. Member of several professional and social organizations.

McKay, John C.: Born February 27, 1931 at Rossland, British Columbia. Received B.A.Science in 1954 in Metallurgical Engineering from University of British Columbia. Joined Steel Company of Canada, Metallurgical Department in 1954. Appointed General Supervisor, Research and Development Department, 1961.

Thomas, Noel: Born Toronto, Ontario. Graduated University of Toronto with B.A.Sc. Degree. Has position as Manager of Research Development with Dominion Foundries and Steel Company.

Thornhill, Philip G.: Born 1918, Maidstone, England. Employed—Wendigo Gold Mines Ltd. 1937-40. Service—Canadian Armoured Corps, U.K. and C.M.F., 1941-46. B.A.Sc. Met. Eng.—University of Toronto, 1950. M.A.Sc. Met. Eng.—University of Toronto, 1951. Employed by Falconbridge Nickel Mines Limited 1951 to present as: Research Engineer, 1951-53; Research Metallurgist, 1954-59; Supervisor Metallurgical Research, 1960-67; Manager Process Metallurgy, 1968; Director Metallurgical Research, 1969. Member—APEO; CIMM; AIME; Electrochem Society.

THE SENATE

SPECIAL COMMITTEE ON SCIENCE POLICY

EVIDENCE

Ottawa, Tuesday, June 24, 1969

The Special Committee on Science Policy met this day at 10 a.m.

Senator Maurice Lamontagne (*Chairman*) in the Chair.

The Chairman: Honourable senators, this morning we have representatives from four different companies. As has been the practice in the past, the witnesses will make short statements followed by a question period.

I shall ask Mr. Laing to speak first. Mr. Laing is the Assistant to the Executive Vice President (Financial) of Dominion Foundries and Steel.

Mr. Alan D. Laing, Assistant to Executive Vice-President (Financial) Dominion Foundries and Steel: Mr. Chairman, ladies and gentlemen, our submission consisted of comments on the questions and the appendix to the letter in which we were invited to submit a brief to the committee. You have our submission and so we propose to comment on a few of the points without repeating our submission. We will attempt to answer any questions you may have on the submission.

There is one matter on which I should like to say something, and Mr. Thomas will speak on some other points.

In submitting claims for additional allowances for income tax purposes and in submitting our request for a grant under IRDIA, we found that many of the activities which we consider research did not fall within the definitions of research in the Income Tax Act and in the IRDIA Act. In our accounts, cost of development work which did not properly form part of the costs of production of operating departments was segregated and was charged to research. Our returns reporting research activities included the cost of all of these activities which had been recorded as research in our accounts.

The definition and interpretation which the Department of Industry publishes says that development work qualifies for financial assistance which uses the results of basic or applied research. Much of what we consider research and development does not proceed from our basic or applied research.

Two projects will illustrate the type of activity which we have considered research and which we have been advised by the Department of Industry may not, in their opinion, be research or development.

In making castings in our foundry the castings sometimes have defects because of non-metallic inclusions in the steel for castings. We did some tests to identify the composition and structure of inclusions. We attempted to relate the frequency of inclusion occurrence under different operating conditions. This was an investigation to determine on a trial and error basis what modifications would be required to reduce the proportion of defective castings, that is, to improve productivity. In the opinion of the Department of Industry, this was a routine metallurgical quality control problem. In our opinion, routine quality control can stop at making sure that customers do not receive defective products and ensuring that the processes are operating to the desired limits. This work went beyond that.

Another example is in connection with the annealing process. In a batch anneal process, coils of steel are set on a base, a cover is placed over them, the enclosure is filled with inert gases and the steel is heated to a temperature which will permit the irregularities in the grain structure of the steel to be reduced which result from cold rolling of the steel. We experimented with a base of different design. From an operating point of view, there clearly were uncertainties to be resolved before we could decide whether to use the new design. In the opinion of the Department of Industry the work appeared to be a verification trial of a newly-engineered device. They saw no evidence of previous

scientific research and development to arrive at the new design.

The purpose of citing these examples is not to say that the representative of the Department of Industry erred in his assessment of our activities. It is rather to suggest that the limitation in the present definition and interpretation of the type of development work that qualifies for financial assistance is too narrow. We regard the cost of innovative activity as research and development whether or not it is preceded by basic or applied research and whether or not there is a significant element of scientific or technical novelty or innovation. The difference on the second point may be only one of what is significant. To us, the significance of the technological change is in the importance of the improvement measured by cost reduction or improvement in quality. Both of these are ways of saying improved productivity.

To summarize, we think some broadening of the interpretation of research and development presently used by the Department of Industry would result in financial assistance to increases in activities which result in improved productivity but which do not necessarily follow basic or applied research and where the significance of the improvement may take into account commercial significance as well as a degree of technical change in the process.

Thank you.

The Chairman: Mr. Noel Thomas, Manager of Research and Development, Dominion Foundries and Steel, would like to say a word in amplification.

Mr. Noel Thomas, Manager of Research and Development, Dominion Foundries and Steel: Mr. Chairman, honourable senators, our brief was in reply to the specific questions suggested to us as a guideline. A summation will perhaps make our feelings clearer.

We would point out that the benefit of research to Canada comes from the innovative side. This is the part usually carried on or promoted chiefly by industry. The recent Government tax concessions and grants towards industrial research have given greater incentive towards this end and are looked on favourably.

Unfortunately, for the large part, other research energies such as universities' research tends towards the fundamental and does not benefit Canada's economic position as well as if the time and energy was expended closer to the innovation side. The recent growth in the universities has demanded staff increases that in a large part have been made directly from post-graduate programs. Thus the educators and university researchers have become less and less familiar with Canada's industrial needs. Their research programs have been sponsored in large parts by government grants, which have also increased and carry no restrictions on areas of research, that is fundamental or applied. All in all, industry and universities have been widening in their relationships. The only sure-fire way to bring them together again is for the control over university grants to carry some means of control over the area of research either direct or through incentives.

The industrial links with government research laboratories are not uniformly strong in all areas. With the advent of the Department of Industry passing on industrial research claims perhaps the communications of applied research needs will be more evident. This, however, is too insecure, and better lines of communication could be established.

There is adequate research manpower available but it needs more incentive to work in innovation and conversely less incentive to work in fundamental research. Let us redirect it. We have good sources of the results of foreign science, so let us adapt to it and let us adapt to it quickly.

That is all I have to say in summation.

The Chairman: Thank you, Mr. Thomas. Now we have Mr. Fisher, Vice President of Planning Engineering and Research Division of the Steel Company Limited.

Mr. A. D. Fisher, Vice-President, Planning Engineering and Research Division, Steel Company Limited: Mr. Chairman and members of the Senate Special Committee on Science Policy, I would first of all like to express our appreciation for the opportunity of meeting with your committee and disseminating some of the thoughts and ideas we have in this particular area. I might say by way of introduction that we have confined our remarks and our suggestions to the area that has to do with the physical sciences and particularly as they relate to the private sector of the economy with specific reference to industry and its contribution to the economic development as far as the overall economy is concerned.

We have directed to the committee some recommendations, and I would like just to emphasize some of the recommendations we have made.

We have stated first of all that we believe that the aim of government science policy as it relates to industry and the private sector of the economy should be to maintain and also to increase economic development of industry and to release its efficiency and its ability to compete in the marketplace, and as a result to improve its productivity facilities, its capacity to meet demands placed on it, the quality of its products and the versatility of its products so that in the marketplace, in the development of the profitability of our enterprise, we can make the maximum contribution.

We have suggested that the Government should encourage business to maintain research and development because of the rather important contribution that research and development can make to these particular objectives I have just outlined. We feel that industry should be left very much to its own devices in determining its objectives in terms of research and development programs, because we feel that we are best equipped in this particular area to determine where the effort should be directed and where the maximum contribution will avail as far as our particular industry or segment of industry is concerned.

We believe that the government can exercise substantial influence in the achieving of these objectives by encouraging industry economically to engage in research and development programs so that there is some benefit through the Government to overcome some of the risk factors involved in the research and development activities which we carry on. We believe there should be some incentive program under the jurisdiction of government to industry to engage in research and development and to maximize the effort in this regard. We believe that these kinds of incentives should be geared to tax concessions rather than some kind of grant or subsidy, so that it is a reward for effort rather than just a stimulus to effort itself. I would like to see this kind of incentive geared to tax areas for the benefits that can accrue from concessions in this area.

We believe that tax incentives should apply to all research and development effort and the results arising therefrom, and we believe there should be a change in present policy so that the benefits that can accrue to industry are not minimized by some of the policies relating to the base period concept whereby industries that have developed a maximum effort in the past in research and development are not penalized by the fact that they have a successful program back of them and so cannot benefit in the future to the degree that they should. We believe the base period should be eliminated and tax incentives should be based on the effort being developed currently in research and development and its benefits. We believe that there should be some regard given not only to the research and development factor, in other words the development of the kind of information that can be applied to the development of processes and products, but it also should be geared to the area of changing research and development knowledge into practical application in a commercial way so that the very high risk involved in getting projects from the research area into commercial development can be minimized.

We believe then that the incentives should include probably the first commercial facility utilizing the results of the research and there should be some benefit in this area to the investment involved to support the effect of that investment.

We believe this also applies to the initial years of the operation of this kind of research and development findings and their application.

We believe that the government should give some recognition to the contributions that can be made through government agencies in centralizing, simplifying and standardizing the incentive programs so that we do not have the complexity in programs that we have at the present time. Then, not only as far as administration is concerned but also so far as the application of industry is concerned we would like to see a simplified approach made to the area of encouraging industry to meet with government programs.

Furthermore, there should be continuity; we should be sure that these programs will continue into the future so that we are not suddenly interrupted in our efforts on programs that will affect us economically. We believe too that the dissemination of information could be improved so far as these government incentive programs are concerned, and that they should be centralized and simplified through some administrative function within government. This should result in a

simplification in the application and administration of these incentive programs. We have run into the difficulty of determining eligibility in many of the sectors that revolve around the application of government programs to the kind of research and development we are carrying on in the determination of eligibility to use this kind of incentive.

We believe there needs to be, and this is an important point, a greater liaison between government and industry in the development and research programs and in the utilization of research efforts. This can be carried on, of course, not only through the research agencies of government by closer liaison, but also in the academic sphere where universities and technical institutes can make their contribution, and closer liaison in this sector would be helpful to industry. This means co-operation not only on the part of these agencies and functions of government but also on the part of industry itself in making use of this source of information and assistance.

We believe too that the Government could be a factor in centralizing and contributing to knowledge, so that information could become more readily available and more simply applied to industry, so that we could have information on discoveries and the results of research made available to industry through various agencies, such as the Patent Office, the Technical Information Services, and so on, in the dissemination of technical information.

Finally, we feel that the Government could be better oriented, not only in its research institutes and organizations but also with respect to industry and the needs of industry, so that this liaison could be made more effective and programs carried on through the councils of government engaged in research and development could more effectively contribute to industry's effort. This, again, means closer liaison and a greater orientation towards applied research and development on the part of these agencies of Government involved in research and development.

Maybe with our tongue in our cheek, we have also suggested that people who are qualified in research and development are sometimes deterred from remaining in Canada by income tax policies that mitigate against their getting the full fruits of their effort.

Senator Grosart: Why do you say "tongue in cheek" for that recommendation?

Mr. Fisher: Well, I suppose we are all influenced to some degree by the income tax situation and its impact upon us personally.

The Chairman: Is it tax exemption for researchers?

Mr. Fisher: Yes, which kind of segregates researchers as a special group.

Senator Bourget: That is not easy.

Mr. Fisher: No, that is not easy; and that is where the "tongue in cheek" comes in.

The Chairman: I will do more research, if that is accepted!

Mr. Fisher: In summation, our recommendations really emphasize the need for industry itself to be encouraged and stimulated to a maximum research and development effort, and we feel that what has been carried on in the area of Government incentive in recent years has given encouragement in these areas. We feel that much more can be done to encourage industry to develop itself in the market place competitively, not just in the domestic market place but internationally, and that research and development and the fruits of research and development can be a major factor in making us more viable and effective in marketing our products and being more competitive world wide.

Thank you, Mr. Chairman.

The Chairman: Thank you, Mr. Fisher.

Now Mr. G. M. Mason, Technical Director at the Aluminum Company of Canada Limited.

Mr. G. M. Mason, Technical Director, Aluminum Company of Canada Limited: Mr. Chairman, ladies and gentlemen, when our company was invited to submit a brief to this committee, we were very grateful for the opportunity to present such thoughts as we have, and I wish to express my thanks to this committee this morning.

We have been engaged in research and development, of course, as long as the company has existed, and we have been much concerned, as have many other people, to establish goals for research and development, to decide what should be done and what should not be done, to devise means for eliminating obsolete research—and this is something we all fall into, I think, because we start a project sometimes which is very difficult to stop, even though it may be obsolete. We have also

been concerned about the people engaged in research. We have to assure them they are making a contribution to the business, that they are part of the business, and that their efforts are appreciated and rewarded.

We are doing a relatively small volume of research business compared to Government, and we do not underestimate the fact that there are complex problems involved in coordinating Government research.

In this modern age science has an impact on virtually every area of our economy, whether it be agriculture, mines, industry, fisheries, and so on. Research and development are tools for the creation of scientific knowledge and the translation of science into practical activities. It seems clear that because of the great impact of science on our whole economy, there is a need to establish a central government agency with authority to direct Government spending in research and development into profitable channels and to ensure the maximum use of science throughout the country.

In view of these considerations, we have recommended the establishment of a co-ordinating authority for Canada's scientific efforts. This function could be undertaken either by an existing instrument or by a new one which might take the form of a department of science and technology. However, we believe it is important to ensure that this group be provided with the authority to take all necessary means to maximize the return from government expenditure on research.

In order that this group be provided with the necessary information from all segments of the scientific community, and from all the diverse areas of the economy, we recommend attaching to the co-ordinating centre a permanent advisory committee with broad representation across the country from the many areas where science is to be applied. An important function of this committee could be the setting of goals and objectives to be met. Furthermore, this committee would be the instrument of setting appropriate guidelines for expenditure on research and development by Government agencies and the assurance that these would be related to the needs of the country as a whole.

Our survival as an industrial nation calls not only for the formulation of an appropriate science policy, but also for its effective implementation. To achieve the latter goal, we believe that science and technology must be represented in our government at the government level by a person who would be fitted by training and experience to lead and represent the Canadian scientific community in an effective manner.

While we have in our brief made a number of other detailed recommendations, the above summarizes and states the essence of our recommendations, which are as follows: (1) the establishment of a co-ordinating authority; (2) the appointment of a permanent advisory committee; and, (3) representation of the scientific community at Cabinet level.

Thank you, Mr. Chairman.

The Chairman: Thank you, Mr. Mason.

Finally, Mr. P. G. Thornhill, Director, Metallurgical Research, Falconbridge Nickel Mines Limited. I understand that we have not received a brief from that company, but that Mr. Thornhill is going to read to us a brief statement which I believe is just now being made available to the members of the committee.

Mr. P. G. Thornhill, Director, Falconbridge Nickel Mines Limited: Thank you, Mr. Chairman. Ladies and gentlemen, I would like to thank you on behalf of Falconbridge for our being invited to this meeting.

Industry needs more incentive to do its own research and development via tax relief, not expanded research and development by government agencies. Thus we believe that the provisions of IRDIA should be amended to apply to all of our expenditure on research and development, so that we will not, in effect, be penalized for having the foresight to do research before some arbitrary date.

Construction and operation of new plants for the practice of new processes—that is, innovations—are subject to risks and expenses that deserve tax concessions and accelerated write-offs. For example, the Nickel Iron Refinery presently under construction at Falconbridge will cost $35 million. Because the process is new it is to be anticipated that start-up of the plant will involve flow-sheet changes and consequent losses in production. We believe that innovative risks of this type merit a depreciation rate at least as favourable as that applicable to other mining installations.

We believe that of the public funds spent on metallurgical process research and development an increased proportion should be directed to research and development on pollution abatement. We believe that public research and development on pollution abatement will benefit our industry, whether successful or not. Thus on the one hand if

practical methods are developed by government research, the problem is overcome. If, on the other hand, the government cannot develop practical methods, it will at least have gained the insight which will help it to treat this particular problem of industry with more understanding.

Present Patent Office practice tends to result in the issue of a higher proportion of invalid patents to inventors using Canadian filing priority than to those using foreign priority. However, because of the unique minority position of the Canadian inventor in his own Patent Office, we believe that this injustice can be rectified with a correspondingly minor additional expense. The promise of a valid patent would greatly encourage Canadian research and development.

We believe further that the present patent system breeds procrastination and that Canadian research and development would be encouraged and accelerated if the chief recommendations of the Ilsley Report were followed.

Thank you, Mr. Chairman.

The Chairman: Thank you very much, Mr. Thornhill. We come now to the discussion period, and here I would point out that everybody is welcome to make a comment even though a particular question has been addressed to another member of the group.

Senator Bourget: At page 3 of the brief of the Aluminum Company of Canada, Ltd. I read:

> In this context, a Canadian science policy needs to have built-in mechanisms for adjustment and self-renewal...

Does that mean that there should be better collaboration, and constant collaboration, between these groups? What, in your view, would be the mechanism necessary to establish such collaboration and liaison between these groups?

Mr. Mason: Our view, sir, was that it would be the co-ordinating committee which would function in that way. We have made extensive use of the task force principle in some of our projects, and this means drawing people from several areas—areas of Government, areas of industry, and areas of the university. This could be done by using the central committee as a focal point for gathering these people together. This was our thought.

Senator Bourget: Then you mention that this advisory committee could be the Science Council, do you not?

Mr. Mason: We are not pretending to say who it should be, but it should be a senior group, possibly a science department of the Government headed by a cabinet representative. But, the advisory committee would be drawn from all segments, including industry, so that you would have available an activating group which would draw together all people from all areas of the community which would be involved in a specific problem.

Pollution has been mentioned. Pollution is a very broad problem. It involves very many segments of the community, and contributions could be made by many areas. The central committee would be in a position, in our thinking, to draw upon these areas, and give them responsibility and authority to do something even if it were only fact finding.

Senator Bourget: Do you think that the representation on the Science Council today is adequate? Are all segments represented on the Science Council?

Mr. Mason: In our view, sir, they are not.

Senator Bourget: They are not?

Mr. Mason: We feel there should be more representation from industry and from the working level of the community.

Senator Bourget: Mr. Chairman, I would like to have the views of the other members of the group on this co-ordinating authority. One gentleman here proposed that there be established a department of science and technology. On the other hand, the Steel Company is opposed to it. I would like to have your views.

Mr. Fisher: I can give you some background to the view that we have put forward which is somewhat opposed to that which has just been presented. We feel that industry itself, to a very major degree, can determine its own destiny. I think it is very difficult for some kind of a centralized committee to adequately define or promote the individual objectives of industry itself in a competitive environment, or to have some kind of a broad policy that can contribute to a major degree across the broad areas of industry itself, because the objectives of individual segments of industry, which relate to its particular function and facility, can be so diverse.

Pollution was mentioned as one area where a united effort could make some contribution, but there are many factors involved even in this area of scientific investigation that apply only to individual industries. Individual industries have their own individual problems and individual objectives. They are competing in different marketing environments, and they are certainly in a competitive environment. So, we feel that the major effort should be directed by the industry itself, or the individual companies involved in that industry, and we feel that we have individual objectives that have to be achieved.

A united effort does not really maximize the achievement of these objectives. Although some benefit can accrue from an overall effort, we feel that the maximum effort can only accrue by using the people, the facilities, and the skills of industry itself working in its own environment towards achieving its individual objectives. If our objective is air and water quality control then we feel we can maximize our effort in this area by endeavouring to correct our own problems in our own environment.

If there is going to be some kind of an incentive in the area of financial contribution then we can utilize that best, rather than having it flow to some kind of central agency where it is going to be, to a major degree, dissipated, and where the benefit is not going to be maximized.

Senator Bourget: Before you call upon other members of the committee, Mr. Chairman, could we hear the views of the other witnesses on this matter?

Mr. Thomas: I think I agree with Mr. Fisher. I cannot quite see how a committee can always work on some of the individual problems that we have. The problem of pollution, I grant you, is more universal among the steel industries, and a concerted effort from Government research institutions...

The Chairman: I think there is some confusion at this stage in that when you discuss a proposal you do not seem to discuss it at all in the same terms. I think that what Mr. Mason had in mind was a new central mechanism at the cabinet level. I am sure he was not favouring that new department, or that new ministry, doing all of the research in Canada.

Mr. Mason: I agree, sir.

Senator Bourget: The proposal is that there be a co-ordinating committee.

Senator Grosart: We are confusing the proposal because the suggestion that there should be a national science policy is very different from saying that the Government should try to run industry, or to tell industry what to do.

Mr. Fisher: Certainly we are not in any way arguing against the need for a national science policy. I think we emphasize the arguments in favour of this. What we are arguing against is the kind of centralized effort that we felt was being suggested, where effort in research and development would be concentrated through some kind of government agency, and to a degree withdrawn from the private sector.

Mr. Mason: I hope I did not give that impression. That was not my intention.

Mr. Fisher: Then we are not at variance. I think some co-ordination would be desirable, particularly in the dissemination of national research and development effort.

Mr. Mason: We have that in our brief.

Mr. Fisher: It must be realized that there are confidentiality aspects to this. We have invested substantial sums in our research and development effort, and from our point of view it would be undesirable to make this kind of information generally available so that we could not benefit from the fruits of our own efforts. There are some areas in which it would be desirable to disseminate our discovery or information, and at present our industry does disseminate this kind of information. However, where it can be a contributing factor to our own profitabilty it is desirable to keep it confidential, we would not want some kind of central agency disseminating such information.

The Chairman: There are people who want to arrive at the same conclusion as yourselves, for the Government to give a greater share of research effort in Canada to industry, but in arriving at that conclusion they say there must be in Canada a minister at the Cabinet table to make sure that it will be done. You can see where the confusion could arise when you start to argue that you are against a department of a minister in charge of these operations on the ground that you want industry to do more.

Mr. Fisher: I am not against the suggestion that we should give industry incentives to do more. I am, however, concerned about setting up a government agency under a minister who may really mitigate against our effort, who may begin to dictate what we should be doing, or where in his view our contribution might be more effective. We feel that industry is in a better position, knowing its industry, knowing its competitive environment, knowing the impact on the marketplace, whether domestic or international, and we feel we should be left to determine in a major degree our own destiny in this regard. If incentive is necessary it should be through some type of tax concession so that we can then use our own thinking, our own initiative and our own objectives as the stimulus to the effort we put forth in research and development, and not be governed by some kind of central agency that might not be particularly sympathetic to our segment of industry and might actually mitigate against our effort.

The Chairman: As Senator Grosart used to say when we were receiving representations from the universities, you want more public money and less public control!

Senator Grosart: A quite legitimate objective for anybody. Again I think there is some confusion. I believe that most of us in this committee believe that you can have national policy without nationalization and without having socialism.

The Chairman: We will probably come back to that later on.

Senator Haig: There seems to be some contradiction between Mr. Mason's proposal and what we have heard here from NRC. On January 29 this year NRC said:

> The fatigue failure of engineering materials is now the most widespread and intractable problem of engineering design.

The problem of aircraft fatigue is one that is mentioned. NRC said they had been working on this problem for about 20 years, and at page 3060 of our report Senator Grosart asked:

> How much of this research work on metal fatiguing is being done in industry in Canada?

The NRC director in charge of this work gave a very short answer, which was:

> The answer is very simple, sir: It is, effectively, zero.

On the basis of our record, NRC are doing research on this very material problem but industry is not. On page 11 of their brief, the Aluminum Company of Canada state:

> There is little spin-off from NRC research that can be used in the aluminum industry in particular.

What is your comment, Mr. Mason, on this seeming contradiction between NRC saying that nothing is being done and you saying in your brief that there is little spin-off from NRC research that can be used by your industry?

Mr. Mason: I can only say that I am astonished, because we have done a fair amount of work on aluminum properties, on corrosion, on structures and strength of structures. We have a structural laboratory at Kingston. I think it is more a question that we have not got together than that we are not using NRC.

Senator Haig: In other words, NRC does not know what you are doing and you do not know what NRC is doing.

Mr. Mason: I fear that is the case. I am rather astonished at this.

Senator Haig: Again on page 14...

The Chairman: Perhaps we might have some comments on this from the steel people.

Mr. Mason: It is an interesting point.

The Chairman: Perhaps we might hear from the steel people whether they are doing some research in this field.

Senator Grosart: On metal fatigue particularly.

Mr. Fisher: I think I would agree with Mr. Mason, that NRC are not aware of what is going on, and I do not know exactly how they would be aware unless it were through some kind of publication, because we do not work with them intimately in this area. Certainly we in the steel industry have put forth a major effort to make steel more acceptable for use and to overcome some of the problems to do with metal fatigue. Mr. McKay, who is in charge of our research and development effort, can corroborate that we have put a lot of effort into this, on the metallurgical and other aspects, to overcome some of the problems of metal fatigue. I believe that a lot of basic work has been done by industry generally on this problem.

Senator Haig: Do you mean to say that for 20 years NRC has been doing work and the industry does not know about it?

Mr. Fisher: We are aware of the information disseminated by NRC.

Senator Haig: Why have a government agency doing one thing and industry doing another? Why have this duplication?

Mr. Fisher: I do not think there is necessarily duplication. There are basic problems that I believe we are both endeavouring to resolve. We are both working in this area, although I do not think it is a closely collaborative effort.

Senator Carter: The lines of communication have broken down.

Mr. Fisher: Certainly I am as astounded as Mr. Mason that NRC is not aware of this, or has propounded the theory that industry is not doing anything. I think they must be aware that we would not be long in the marketplace if we were not.

Senator Grosart: In fairness, if I remember my question it was related to aeronautics.

Mr. Fisher: We are making very little contribution in this area.

The Chairman: What about yau, Mr. Mason?

Mr. Mason: I can only say I am astonished that the work we are doing at Kingston was not known to NRC. Aircraft is not a major tonnage outlet for aluminum today, as it was in the time of war. We are probably working in other areas of transportation, such as aluminum overhead conductors and other types of structures not associated with aircraft. If they have been working in the aircraft area, again I am surprised, because we have not been aware of it.

Senator Haig: On page 14 you mention developing single family aluminum housing of good quality at a cost more within the reach of wage earners than that of housing constructed by standard methods. Could you give specific comparisons between the two types of housing and how government agencies assist in this program, and what is the role of CMHC or the NRC division of building research?

Mr. Mason: These housing projects which are referred to here are prefabricated homes built in a factory and shipped to a site. The aluminum is not necessarily a major portion of the buildings. It is an effort to produce low-cost housing as a contribution to the general housing shortage. It is not necessarily aluminum application. Aluminum is used where possible, but these are prefabricated houses, equipped and furnished and they can be installed on a prepared site within three days. This effort is more in the housing effort than in the aluminum application effort.

Senator Haig: Is NRC a division of building research? Do you get any assistance from them?

Mr. Mason: I am sorry, I do not know. We are using Central Mortgage in the financing of these homes.

Senator Bourget: Was it fully developed by your own company?

Mr. Mason: Yes.

Senator Bourget: What has been your experience regarding the cost?

Mr. Mason: It has cost more than we had expected.

Senator Phillips (Prince): What about CMHC regulations? I think at one time they only allowed one of four of your units.

Mr. Mason: I do not know the answer, sir.

Mr. Gilbert Proulx, Manager, Public Relations (Research), Aluminum Company of Canada Ltd.: I am not familiar with that field. I do know that these houses were gradually developed by our company with the co-operation of CMHC. Quite a number of features had to be gradually adapted until there was acceptance of our design. That was the first effort that led to what we call the Alcan designed homes. Following that, in the second phase, we went into these factory-built houses to the extent that someone has said we are supposed to be the largest house builder in Canada. That is something we have been gradually developing throughout the years.

Senator Phillips (Prince): I did not make my question specific enough. If you are opening up a subdivision I understand CMHC regulations permit only 25 per cent of the homes in the subdivision to be prefabricated. Does that regulation still exist?

Mr. Mason: I do not know the answer; I am sorry. It could well be.

Mr. Proulx: I know that we have some housing developments where all the homes are built by our company. To what extent the percentage of prefabricated houses on a particular site is, I am unable to say.

Senator Bourget: Coming back to the question of aluminum, it says on page 6, paragraph 6:

> Encourage the reapportionment of research activities in order to lower the national investment in basic or pure research and to correspondingly increase that portion allocated to applied and developmental research...

Do you mean by this that there is too much basic or pure research done today? In your view, what should be the role of universities and research? Should it be limited to pure research and leave development and innovation to Government agencies and industry?

Mr. Mason: Certainly the universities can make a valuable contribution and we have worked very closely with some universities. We have given them some projects to work on for us. In other words, in a sense we have subcontracted specific projects to university research. This has been very fruitful, because we are forming an association with the university. Their people meet with ours and there is a stimulation between the two which we find very beneficial. We hope to increase this. There is the question of how much pure research should be done. We feel that the government agencies are highly oriented towards pure research whereas they could be more strongly oriented to applied research.

Senator Robichaud: Mr. Chairman, could I be permitted, later on, to ask a couple of questions?

The Chairman: By all means. I think Senator Kinnear was waiting, and also Senator Haig.

Senator Haig: I will pass.

Senator Kinnear: I think most of the questions I had marked have been answered. Would you like to give a table on the percentage of basic and applied research and so on? How much of the basic research would you say should be used in Canada and how much on applied and development research, because the small end goes to research and development. How would you like it divided?

The Chairman: To development as opposed to pure and applied research?

Senator Kinnear: That is right.

Mr. Mason: It goes without saying that there must be pure research going on. This is an important contribution to the on-going of the scientific community and the industry and also to the development of the country as a whole. We have found that the government agencies are inclined to do more fundamental research or pure research than applied research and we should like to see the proportion changed. I am sorry that I cannot suggest an ideal arrangement. I do not think anyone knows of an ideal arrangement.

Senator Kinnear: But, you would like it changed from basic to another?

Mr. Mason: To more of an applied research.

Senator Kinnear: Now, I should like to switch to Dofasco, page 7 of the brief:

> While Canadian universities graduate scientists and engineers skilled in their respective disciplines, they lack a broad knowledge which would result from a well-rounded education. Graduates need improvement in the following areas:
>
> 1. Communications—the effective use of basic English—especially in written reports.
> 2. Problem-solving—the development of a good analytical approach to problems.
> 3. Economic realities—the need to relate scientific learning to dollar costs.

That is something that I have been interested in for a long time. I feel that our scientists are trained in such specific fields and that it is a very narrow field. I am wondering if this should not be changed and that, as this report suggests, they should have a little broader knowledge. Some scientists or engineers are no sooner out of college and into work than they are asked to go back and get some knowledge of business administration. It does seem to me that that might be a good thing to do. What is your idea in regard to this Dofasco?

Mr. Thomas: To enlarge on it, I think the problem, as I mentioned in our summation, is that the university, as well as the need for universities, has grown and you have had to staff it with just recent graduates. It is only

natural to assume that these people would not have economic reality and would have not been exposed to the needs for industrial research. They have not been exposed to industrial needs, or to the needs for industrial research. They are graduate students and, in these days, it follows along logically that they will be a little short on economics.

We would like to see more industrially trained people in the university staff.

The problem of solving communications is probably more a curriculum detail in the university's approach to the problem and oftentimes it is quite theoretical and reflects the kind of tutors they get at the moment.

Senator Grosart: I take it you mean "fundamental English" and not "Basic English," which is a very different thing.

Mr. Thomas: I am sorry.

Senator Grosart: Basic English is a particular discipline, invented by a man named Ogden in Cambridge. I am sure you do not mean Basic English.

The Chairman: It was a kind of international language.

Mr. Thomas: I see.

The Chairman: But you want this one to be Canadian.

Senator Grosart: The "c" in Basic English is Chinese.

Senator Kinnear: The Steel Company says, on page 13 of their brief:

> The idea behind PAIT is sound, but this company, and presumably others, hesitate except as a last resort to use the program because of the administrative detail demanded in advance of project approval or in withdrawing from a project, the necessity for full disclosure of results to government employees, and the stipulation that results be exploited within a reasonable period of time in Canada.

All you say is that you do not like PAIT and prefer a tax concession.

Mr. Fisher: I think that is a very broad statement, to say that we do not like PAIT. We have benefited to some degree from the use of PAIT in research programs, but we feel the inconvenience engendered by the regulations under PAIT make it very difficult for industry to apply it.

For one thing, we have to make disclosure of all of the information, much of which is confidential in a broad area of research, both before and also after PAIT.

As the results of the research program are developed, we also find that there is a tremendous amount of administrative detail developed in trying to keep a PAIT project.

We have to provide the kind of information which it is very difficult to provide, and which some say they would prefer to maintain as confidential, and cannot.

I think Mr. McKay, who is in charge of our research development effort, has been involved very intimately in the work with the Department of Industry, relative to the application of PAIT, and I would like him to comment on it.

Mr. J. C. McKay, General Supervisor of Research, Steel Company Limited: PAIT is a very useful scheme where the particular projects have a high reward, a very high risk, and are continuing on despite a high possibility of failure.

This is a place where you would be justified in going through administrative detail to seek PAIT. On a normal project of research, there usually is a high reward and there is a low risk. This would not justify the effort to apply for PAIT.

Senator Grosart: May I ask a general question, arising out of the discussion on PAIT and IRDIA and the other programs? There seems to be a consensus among the industrial firms that have been before us, that there is quite a bit wrong with these programs. To your knowledge, have these deficiencies in the planning of these programs been brought to the attention of the Department of Industry, Trade and Commerce?

Mr. Fisher: Yes. Certainly in our application, for example, for PAIT, we have objected to some of the requirements. In order to get the tax incentives under some of the other programs, we have had to provide a tremendous amount of detailed information, and all of this encompasses us in a rather major effort and a lot of time in providing the kind of information.

Mr. Darby, our tax accountant, has been involved in trying to get approval of the financing under the various government schemes and he has been involved in the detail in trying to get approval. I think he might comment on this and speak of the difficulty of securing approval, and on some

of the objections we have raised to the provision of information.

Senator Grosart: I was not concerned with the specific objections at the moment. I take it there are objections, because we have had them in every brief from industry.

My question really is, what has industry done to try to correct this? Do you just complain individually to the Government that you do not like this or that? Did it ever occur to industry to get together all the people interested in these programs and give your view to the Government as industry's view about the programs?

Mr. Fisher: I would like Mr. Darby to comment on that.

Mr. W. A. Darby, Tax Accountant, Steel Company Limited: Mr. Chairman, I believe the Canadian Manufacturers' Association in their brief have indicated to the Government that this PAIT problem more or less punishes those people who have made a substantial investment in research and development, in the earlier stages. A company which invested a substantial amount in earlier years in research may not, and as a result did not benefit from the programs to any extent.

In regard to the so-called inequity—if you would call it that—it was accentuated when they brought in PAIT.

I sit on the CMA tax committee and at least on two or three occasions this whole matter has been brought up. The Government wants an ever-increasing return compiled on the research and if it does not show a compound growth every year you do not get a tax benefit.

I filed a recent tax return and with an expenditure this year of between $2 million and $3 million, the amount of tax relief we are getting is measured in tens of thousands of dollars, because in effect we spent such a substantial amount in the previous three to five years. This has been indicated to the revenue department.

Senator Grosart: This is an interesting problem. We have the base period problem at both ends—termination, and the early cutoff, and so on. We have all these problems; but the last witness said. "I know it has been brought to the attention of National Revenue". Anyone who understands the political process must know that National Revenue are not going to become crusaders for industry with the Department of Industry, Trade and Commerce.

My question is, what has industry done as a whole to get this changed? It is all very well to say the Government should do this, the Government should consult us, the Government should co-ordinate. What about having it the other way around?

Mr. Mason: I think you have made a good point. I think we have complained to each other.

Mr. Laing: May I talk from experience, from the point of view of STELCO? As I understand, we dealt with the Department of National Revenue, trying to explain to them what we thought was research. They agreed they could not assess it and asked if we would gather information together in tremendous quantities to be sent off to Ottawa for assessment by the National Research Council. They did the assessment. There were some debateable items and some were sent over to the Department of Energy, Mines and Resources for a further assessment. Again they gave a different opinion, and it came back to us through the Department of National Revenue.

The current submission by CMHC has been through the Department of Industry, because there is some doubt about the effectiveness of PAIT.

One of the problems is that we are trying to get information together on what happened in the past on PAIT type programs. Another problem—and I don't know if it is the Department of Industry's problem or just industry's problem—is trying to define what industry is trying to do in a specific project.

As I mentioned previously, sometimes our understanding differs somewhat from the definitions in the regulations. We have had some trouble in that respect in trying to describe what we intend to do.

Senator Belisle: Mr. Chairman, may I say how much the people of Sudbury and district have appreciated the excellent public co-operation and public relations they have had with and under the leadership of the management of Falconbridge Nickel Mines Limited. May I also add that your new refinery at Falconbridge, Mr. Thornhill, is not only a boost to the district but is an act of faith in the potential of Sudbury and district.

I am also pleased to say, Mr. Chairman, that had it not been for the generosity of International Nickel Company and Falconbridge Nickel Company, the Sudbury university complex would never have been possible, and I am pleased to make note of that.

Now, in your brief you suggest that, of the public funds spent on research and development for metallurgical processes, an increased proportion should be directed to research and development on pollution abatement.

Of course, pollution also consists of air pollution. How much money are you presently spending on research and development on air pollution by sulphur dioxide? I might say that this is of vital concern to all of northern Ontario.

Incidentally, I just read that International Nickel, which has three chimneys the highest of which is approximately 660 feet, now wishes to put up a new chimney of 1,200 feet.

Mr. Thornhill: It is 1,250 feet.

Senator Belisle: What will be the height of your stack at the new smelter? Have you made research regarding that?

Mr. Thornhill: Yes, and we have been very sharply told by the Department of Transport that we cannot increase the height of our chimneys one foot higher than they are now. We have the misfortune of being in the cone of approach to Sudbury airport. This is a matter with which Falconbridge is very deeply concerned, because we are under very high pressure from all sides.

I cannot tell you exactly how much we are spending this year, but certainly it is many times more than in any previous year.

Senator Carter: Does the height of the chimney have any other effect than dispersal of the gases? It takes them up into a higher air current and that sort of thing, I suppose.

Mr. Thornhill: It simply dilutes the atmosphere. You cannot make the sulphur disappear.

Senator Belisle: But you can extract the sulphur from the smoke content before putting the smoke into the atmosphere. How much are you extracting, or how much sulphur is going through your chimney? Is it 90 per cent clear?

Mr. Laing: The Government has published information on this aspect of pollution to the effect that the additional height is, with respect to sulphur content in smoke, a valid anti-pollution measure.

Senator Belisle: I have read that particular publication more than once, and with what I have read and with what I have been told I conclude that it is left to the discretion or direction of the company, according to how much sulphur they might be able to sell, just how much they are willing to extract.

Mr. Thornhill: I am afraid you are not up to date on the legislation which the Ontario government is now making us feel.

Senator Belisle: What percentage do they permit you to let out?

Mr. Thornhill: It is not a question of percentage. It is a question of the number of parts per million of sulphur dioxide in the air at ground level in the vicinity of the operation. If you have an operation which puts out one pound a day of sulphur dioxide and, if this one pound gives a concentration of above .3 parts per million, or whatever the figure is, the operator will be in violation of the law. If, on the other hand, the operation puts up 1,000 tons a day but manages to keep the concentration level as measured below .3, the operation is not in violation of the law.

In other words, you can pollute Canada but you cannot pollute one square inch or one square foot of Canada.

Senator Belisle: Then just what is the reason for the high chimneys?

Mr. Thornhill: Not in order to avoid polluting Canada but to avoid breaking the law.

Senator Belisle: How much is being done by other companies to control their pollution?

Mr. Fisher: We are under Government regulation, too, and there are also incentives for us to minimize pollution both in air and water. The Steel Company of Canada in its operation in Hamilton has spent in the last six or seven years approximately $18 million in control of air and water pollution. There has been a very substantial effort on its part to try to minimize the effluent going into the surrounding waters and air, or simply the environment.

Certainly, in all our new installations we do our utmost to so control the effects on environment. For example, in our new plant which could possibly affect Lake Erie we will be able to maximize efforts to control the effect of the effluents by putting in the latest devices and using the latest technology for both water and air control, because we are putting in completely self-contained systems so that we do not discharge effluents into the lake. If there is any pollution it might be of a thermal nature.

The same is true with dissemination into the atmosphere. We are using the best electrical equipment, electrostatic or other devices, to maximize removal of contaminants.

In Hamilton, where we have much older facilities, it is more difficult to apply the results of research in order to minimize the impact of environmental pollution. But again we are spending a tremendous amount of money in that respect.

We have a program going right now endeavouring to contribute to the cleaning up of Hamilton Bay. We have already spent $8½ million in the last six years in controlling discharge to the bay and cleaning up the effluent. We also have a program at the present time whereby we have approved $2½ million, and we have one amounting to $5 to $6 million in the engineering stage also designed to try to clear up the situation. But there are some serious problems that technically have not been overcome. There is the problem of how to remove certain contaminants from effluent in the water. There is at the moment no economic device for removing certain contaminants. So what do you do? Do you shut down the industry? Remember we are making a substantial contribution to the economy and viability of Hamilton. So what do you do to maximize your research and development to overcome these problems? We are working closely with O.W.R.C. and the Department of Health in endeavouring to bring some method of control or some degree of control to the situation. Furthermore our company is working with other industry to minimize the effects of pollution.

Senator Bourget: Is the government helping you financially in trying to solve the problem?

Mr. Fisher: We feel there is not too much incentive from government in the area of tax incentives. We would like tax incentives on the development of equipment to clear effluent so that the equipment for doing so would be tax free certainly from the point of view of sales tax. Where we are contributing with very little economic benefit to this effort to clean up the environmental pollution and to control air and water quality, we feel there should be some incentive given to industry in this particular problem area to spend more money and to maximize their efforts. Of course we are in a better position than some of the smaller industries. We can afford to spend more money to maximize our effort in this area. But when you consider the profitability of smaller industries and where they have old installations, it is rather difficult to justify the kind of expenditure involved.

Senator Bourget: Now, I am asking this question of all the witnesses. In general would industry prefer tax incentives to subsidies or grants from government? Am I right in thinking that they would prefer tax incentives?

Mr. Mason: I would say yes.

Mr. Laing: Definitely.

Mr. Fisher: We have emphasized that in our brief.

Senator Bourget: What kind of incentives would you suggest for the innovative parts of research? It appears that it costs a lot for any company to put a new product on the market. In fact it has been said that it can cost about 75 or 80 per cent of the total cost of the research done to put a new product on the market. Would you be better aided by tax incentives or would you be better aided by subsidies and grants?

Mr. Mason: If I may speak, I would say tax incentives.

Senator Bourget: Alone?

Mr. Mason: Alone.

Senator Grosart: Would you prefer tax incentives to contracts?

Mr. Mason: Yes.

Mr. Fisher: We would concur in that.

Mr. Laing: I think your words were research and development in relation to new products and getting them on the market, and with regard to contracts, I don't know how this would work out. It could work, I suppose, with incentives related to expenditure.

The Chairman: If you have tax incentives you can do research in the fields in which you are interested but if you get a contract from the government, that may not coincide with your own program. However, you are not opposed to contracts?

Mr. Thornhill: There is a point that has not been brought up as yet with respect to the comparison being made, and I think is something that all witnesses here have experienced if I can judge what they have said correctly. Not only does it take a tremen-

dous amount of work on the part of the applicant in preparing his story for this begging procedure, and that is what it is, but there are tremendous numbers of government people involved too. They come and they go and you have their travelling expenses and you may get no for an answer, and many times you get maybe, and a lot of time is being spent in this way. So far as the scientist in industry is concerned, much of his time is taken up in dealing with people outside and trying to get the points across. This costs money; it all costs money.

Senator Grosart: Well, it takes a lot of time for your sales force to go out and sell things, but you do not consider that begging. It seems an extraordinary statement that when the government provides incentives you feel you are being asked to beg when in fact what you are doing is getting free money. I will beg at any time for free money.

Mr. Thornhill: There are some officials who tend to give that impression but there are some who don't.

Senator Bourget: Am I right in saying that what industry wants today is a simplied system of incentives program administered by a single agency so that you do not have to go around all the agencies. Would such a system be practicable and would it meet with your objections to dealing with several different agencies?

Mr. Fisher: If it is practicable in this particular area, we feel it should be done. We are not sure it is practicable, but we have not examined it because we are not too intimately involved in the process of government, but we feel a simplied system in dealing with a single person and a single agency would benefit us. Then we would know who we were dealing with and we would know the degree of justification to be applied to get the benefit of research and development through incentive programs. We feel it is necessary to minimize as much as possible the effort to justify our application, but it is a very difficult and complicated procedure. It is difficult to get your points across. There is a tremendous effort to be put forward in demonstrating justification while these efforts if applied to research and development could be most productive.

Mr. Mason: I would add another point concerning this, and that is the point of continuity. We have had these changes in programs and this has been difficult because we deal now with one government agency and then with another. If there could be some guarantee of continuity it would assist industry in dealing with government agencies and planning for whatever the incentive might be. It would also be of tremendous help if we were dealing with one government department.

Senator Bourget: But that is relative. Surely if you are doing some research and then you find that you are not going to achieve any results from it there has to be some mechanism to stop this particular program or research project.

The Chairman: To stop the particular research project but not to stop the incentive program.

Mr. Mason: A project may have become obsolete while we have been working on it; therefore, we must stop it. But there is an inclination to keep the thing going because the people working on it like it. This happens too. They say, "This is interesting. Let's keep on doing this." We must say, "No, the incentive has disappeared, and we must stop this."

Senator Grosart: On the question of tax incentives, I think we should be clear that it depends upon the characteristics of the particular industry, generally, the main characteristic being size, as to whether they prefer tax incentives or other methods of support.

The Chairman: Was your question related to this, Senator Carter?

Senator Carter: I was a bit confused. The reply to Senator Bourget's question was that they preferred tax incentives, and I gathered that they preferred tax incentives to the present program.

Senator Bourget: To grants and subsidies.

Senator Carter: Yes. Then, when asked whether they would prefer a simplified subsidy from one agency, they said "Yes". I did not know whether they preferred that to tax incentives or not.

Mr. Fisher: No, in collaboration with that—in other words, tax incentive programs administered through a single, central agency, if possible, and under a simplified set of rules and regulations.

Senator Carter: But you still want tax incentives?

Mr. Fisher: Yes, definitely.

Senator Haig: They want a central agency to which they can apply for the program and, if it is approved, they want a tax incentive to write off the expenditures.

Senator Carter: There is only place to go for a tax incentive, and you have another place for grants; so, that is two. When you are looking for tax incentives for research and development or innovation, how far are you going? Are you including market research and economic research in your innovation?

Mr. Fisher: I think this is worthy of some consideration, but our application of the grants up to the present time has been confined to the research and development in the technical areas. Certainly, effort involved in commercial research and other areas of research do not gain any Government support.

Senator Carter: But that is where your big expenditures are?

Mr. Fisher: Certainly, they are major, and on the international market some companies are to a greater degree than we are involved and the expenses have been greater to exploit these kinds of markets and to research them. Maybe it is good for the economy, and maybe some incentive in this area would be justified.

The Chairman: Your tax incentives program would not meet the situation of new industries or new products with a high technological content?

Mr. Fisher: Not necessarily.

Senator Carter: The problem I see with these new products is this, that I suppose you could get around it by limiting it to certain industries, but there are certain other industries where new products come out just to compete with another new product. Take the cereals industry. Every day somebody gets a new "Popsie" or something out which is a so-called new product but which, basically, is the same as the other one, and there is no innovation.

The Chairman: These are the innovations Senator Grosart used to make!

Senator Grosart: "Switch" research.

Senator Carter: When the consumers affairs committee met two years ago we found companies spending tremendous amounts of money just putting a new product on the market, and the same could be said for soaps and detergents which really were not new products but had some little gimmicks which made them different from the other ones. I grant that this is not true of the aluminum, steel or other kinds of industry.

Senator Grosart: Don't think it is not.

Mr. Mason: It would be more true of consumer products like breakfast foods.

Senator Carter: I would think so, but you have difficulty in drawing a line.

Mr. Laing: Our thinking in coming here is about scientific research and on product and process improvement. Our concern has been partly with the degree of process improvement. A lot of ours in the Dofasco part of the steel industry appears to have been involved in a great deal of development and not proportionate to the amount of applied research involved, and that part of innovation we think could be supported. You are suggesting that market research and commercial research are also research that may be worthy of support, but it is a problem of definition. It is a problem of definition now because it is difficult to see as to whether we think there are grounds for the support of commercial as well as technical research. I am not prepared to comment on that at the moment.

Senator Grosart: Are definitions and procedures easier in defence programs compared to civilian programs?

Mr. Laing: I do not know.

Mr. Fisher: We have not been involved in defence programs.

The Chairman: With National Research Council grants?

Mr. Fisher: No, we have not.

Senator Grosart: Most of the comment is on IRDIA and PAIT?

The Chairman: We are told that when these grants are administered by scientists rather than accountants, the administrative difficulties are much less great. I do not know if it is true, but you have no experience in that field?

Mr. Laing: No.

Senator Grosart: Do you think it would be possible for the Department of Industry, Trade and Commerce to write clearer definitions on research and eligibilities than they have? Is this a problem of semantics? Are they just bad definitions?

Mr. Laing: They become more detailed. First there is the act and then the regulations, and then there is interpretation. I think they are making an effort in that regard. Speaking again from my own experience in this area, it is a problem partly of description, and I think if we understand the limitations they are placing on what they consider eligible scientific research and development, the definition is too narrow, and that is the basis of our complaint.

Senator Grosart: Could any of the witnesses give an idea of the percentage of turn-downs you have had on applications to IRDIA and PAIT?

Mr. Darby: This is a "shotgun" figure, but I would estimate something from 5 to 10 per cent on those items we have applied for.

Mr. Fisher: We do a lot of screening ourselves before we go to the effort of making an application.

Mr. Darby: Another item is where the amounts we have spent are immaterial and would not warrant the amount of administrative effort to get them.

Senator Grosart: Would that be a high percentage?

Mr. Darby: Just a "shotgun" figure, around 10 per cent we would kick out on small items, but it would not a high dollars volume.

Senator Grosart: That makes it a total of 20 per cent of applications which, one way or another, you feel could qualify except for various red tape and other reasons?

Mr. Mason: They are good figures, 10 to 20 per cent.

Senator Grosart: That is not too bad.

Mr. Mason: This is the energy involved in convincing these people these are valid cases.

Mr. Laing: Our experience of this is that we do not bat as well as the opposition, apparently.

Senator Bourget: You do not have such good pinch hitters.

Mr. Thornhill: We have 100 per cent so far.

Senator Grosart: 100 per cent yeses?

Mr. Thornhill: There have been 100 per cent turndowns so far. Well, I will not say "one hundred per cent", because Falconbridge has never applied for PAIT as yet. We have never applied for PAIT in any way for anything, but we are attempting to get some money back now under IRDIA.

Senator Grosart: No runs, no hits, and maybe a few errors?

Senator Kinnear: I should like to ask a question with respect to the effects on human beings, animals, and vegetation of exposure to certain chemicals. You mention this on page 18. I am wondering whether you have noted any long term effects on the eyes and the ears. What side effects have you noted?

Mr. Mason: In any industry there are noisy operations, and we have used the regular commercial measurements for noise, and where there is a high noise level we provide the workers with protective devices. I feel that earlier on in industry the danger that might be done to hearing by high noise levels was not known, but it is very well defined. The Department of Health can give us specific levels that are tolerable, and if these levels are exceeded then we provide the men with protective devices, which are nothing but ear plugs, but which have the effect of lessening the possibility of damage to ears.

Senator Kinnear: Have you noted any deafness?

Mr. Mason: In our industry we have not that many operations of this kind. There are no cases that I know of in which deafness has occurred.

Senator Kinnear: What about side effects of working near chemicals? For instance, I come from a town which is quite different from the one Senator Belisle comes from, but there happens to be a nickel company there, and there are a great many who suffer side effects from the chemicals used. They have what is known as nickel itch, and they suffer greatly from it. Are there any side effects from the chemicals that you use at Alcan?

Mr. Mason: Many people are allergic to specific chemicals. An example I could mention is that of coal tar pitch, which we use in the preparation of electrodes, and which we

handle in carload lots and sometimes in shipload lots. We have found that some men have to be protected from the effects of pitch on their skin. Usually, when we find a man who is susceptible, we put him on a different job. But, this is done only by trial and error, because it is very much a personal thing. These people are allergic to certain things. In our industry there are not very many of these people, but sometimes a man will develop hay fever or asthma because he is working in a certain environment, but in that same environment there will be other people working who have no difficulty whatever. But, such a man cannot work there, and we move him to some other job.

Senator Grosart: Do you report a case such as that to the Medical Research Council?

Mr. Mason: I cannot say that we do, senator, but certainly we have good internal records of people who are moved for reasons of allergy.

Senator Grosart: It would seem to me to be a very fit subject for research under a national science policy. If all these cases were brought together from various industries across the country somebody might be able to find the answers to these kinds of allergy.

Senator Kinnear: I notice from reading this that you own a farm in the Saguenay district. Have you found any difficulty there with the animals?

Mr. Mason: The animals in this case eat the fodder which absorbs the toxicological matter from the air. The animal is not affected if it does not eat the fodder. So, we bought this farm to determine precisely what the level of tolerance of farm animals was to the fodder. We have worked with several universities in developing the levels which can be tolerated. It has no effect on human life whatever, so far as we have been able to determine. The animals are not affected, but the fodder absorbs the undesirable elements, and when the animals eat it they are adversely affected.

Senator Kinnear: As Senator Grosart has said, it is important to report these effects, because now we are finding that there are toxic conditions from different plants. It has happened in Port Maitland, which is 20 miles from my home town, and it has happened in Newfoundland.

Mr. Mason: We have published everything that we have done. This has been published in various medical and other journals.

Senator Grosart: It would seem that you have an animal farm, but not a human farm.

Mr. Mason: We have many human farms. We have people working right in the environment, and they comprise the human farm.

The Chairman: Before Senator Kinnear proceeds to another line of questioning, does any member of the committee have a question on this particular topic?

Senator Belisle: Yes, Mr. Chairman.

Mr. Thornhill, in your opening statement you said:

> Present Patent Office practice tends to result in the issue of a higher proportion of invalid patents to inventors using Canadian filing priority than to those using foreign priority. However, because of the unique minority position of the Canadian inventor in his own Patent Office, we believe that this injustice can be rectified with a correspondingly minor additional expense.

Can you give us a more precise definition of that?

Mr. Thornhill: Yes. There is Rule 39 of the Patent Office Rules which gives the patent examiner power to demand that the results of a patent search in a corresponding application for that same invention in another country be made available to him. Since 70 per cent of all patents filed in Canada were filed first in the United States, and since the United States has a very efficient searching system for prior art, the use of this rule means that the Canadian Patent office does not have to do a very arduous search in that percentage of cases. In fact, it does not have to do it in 90 per cent of the cases, because 90 per cent of all patents filed in Canada are filed under a foreign priority date.

But, the Canadian scientist or inventor who files firstly in Canada does not get the benefit of this search done by others, so we have a relatively inexperienced staff of examiners in the Canadian Patent Office who, because they are able for the greatest proportion of their work to rely on others doing their searching, are somewhat at a loss when presented with such a case. You might say it is a unique problem, but it is our Patent Office.

Senator Grosart: Is not the answer that our Patent Act is so hopelessly out of date that it puts Canadians in an impossible position in respect of filing patents?

Mr. Thornhill: No, sir, I do not think that is it. I think the answer is that we are in a unique position in that 90 or more per cent of the filings are not done by Canadians. Here is a Canadian agency that is working 90 per cent for foreigners.

Senator Grosart: But the Patent and Trademark Institute of Canada told us one of the reasons is the obsolescence of our Patent Act, which has restrictions found in no other country in the world.

Mr. Thornhill: It also has rule 39, which I do not think every country has. Rule 39 gives at least good patents to those of us who know enough about it to file first in another country.

Senator Grosart: This in itself is an absurdity. It is absurd that the way to protect a Canadian invention is to file first in another country.

Mr. Thornhill: This is, in effect, the situation.

Senator Grosart: That is why I say it is an obsolete act. I do not think it has been revised or amended significantly in 40 or 50 years.

Senator Carter: We were talking about the stimulation of research and incentives. In the Aluminum Company of Canada brief, on page 6 in paragraph 8 you suggest that we should:

> Develop risk-reducing or risk-sharing mechanisms for research and development in potentially beneficial activities. Contribute, through a variety of well-tailored, flexible and appealing means, to the gradual increase of the overall national investment in these activities at least to the level reached in industrial competitor nations.

I wonder if you would elaborate a little on that, especially on what you consider "beneficial activities" and a "variety of... appealing means". We have mentioned tax incentives. Have you something else in mind?

Mr. Mason: Since we wrote that I think we have modified our views to the point where we feel that tax incentives are the real thing we would favour.

Senator Carter: I was wondering if you had other ideas.

Mr. Mason: No. On further thought we have come to the conclusion that we prefer the tax incentive method.

Mr. Proulx: For the smaller organizations there might be a system of grants and subsidies.

Senator Bourget: In your brief you mention collaboration between government and independent innovators. What would be the role of industry? Would it be to give financial help to independent innovators? We should be interested in having good products invented by some independent people. Or should it be the role of government to help independent innovators financially, by setting up a kind of crown corporation? I think industry itself should be interested in finding and hiring that kind of person, or helping him to develop a product from his invention.

Mr. Mason: I suppose he must find a sponsor.

Senator Bourget: That is it. There is that kind of organization in the United States, in Boston, under Mr. D'Iorio.

Mr. Mason: The independent innovator is a valuable man who needs encouragement. If he cannot find a sponsor, what does he do? Can he get help from the Government?

Senator Bourget: Do you not think that should be the role of industry? Surely industry is looking for such men, so why does industry not take an interest in hiring that kind of person? It is all very well for the Government to do a lot of things, such as giving tax incentives, but I think you would agree that industry should be ready to help that kind of person.

Mr. Mason: We have done.

Senator Bourget: I refer to people with brains, genius, whatever you call it.

Mr. Thornhill: How do you hire somebody independent and keep him independent? Once you hire him he is dependent on the industry.

Senator Grosart: How do you find a winner? That is the problem.

Senator Bourget: Help him financially.

Senator Grosart: There are 1,000 cranks for every winner.

Senator Bourget: I suppose everybody would like to help someone who is not a crank, someone who has a good product. Should it be the role of government to help such a man financially or should it be the role of industry?

Mr. Laing: I understand we are suggesting incentives, to the extent that industry decides what research should be undertaken. We are looking for some participation or encouragement, not to the extent of 100 per cent reimbursement plus a profit percentage. Our industry has to put its own money on the line and do the research. If an independent inventor has an idea with the appeareance of the possibility of commercial success, unless I misunderstand the attitude of this panel, industry would like, where possible, to think it is industry's function to work with that man. However, that means paying him a royalty, or assisting him with a patent application, or in a variety of ways. Industry still sees that as a valid effort, and I do not know that we are suggesting straight monetary encouragement to inventors by the Government. They could be assisted through things like the patent office mechanics.

Senator Bourget: The reason I asked my question was because of what was said in the brief of the Aluminum Company of Canada.

Mr. Laing: Then maybe I should shut up.

Mr. Mason: I agree with my colleague.

Senator Grosart: On page 13 of the Steel Company of Canada brief, in recommendation (ii) they speak of Government science policy overall and suggest that subsidies be granted

> ...only when such research is recommended by industry and is beyond the capacity of industry.

As a statement of overall government policy that seems a bit surprising. Did you mean to limit it to funding in industry?

Mr. Fisher: One of the points we are emphasizing is that there must be a closer collaboration between efforts through government agencies involved in research and development, that it should not be wasteful. If the fruit of the effort by government does not in some degree contribute to the effort we are making in the environment in which we are working, what really justifies the government effort, unless it is in the social or welfare areas, or in some other area? When it is confined to the contribution it can make to industry, then I think industry has to be involved. We feel that industry should have some voice in or some liaison over the kinds of programs that should be carried on. This means that the objectives we have established for ourselves should also become the objectives of the government agencies. This should arrive eventually at some kind of economic benefit to the industry or to the company the operation may be contributing to. This is why we feel the emphasis should lie in this area.

Senator Grosart: I take it what you are saying is that this statement refers only to funding of research efforts in industry?

Mr. Fisher: Yes, that will contribute to industry's effort.

Senator Grosart: As worded, your statement takes in all government funding.

Mr. Fisher: Oh no. We confine our submission to the physical science area where industry would be involved.

Senator Grosart: Are you then saying there should be no federal Government initiative in the industrial sector in national science policy?

Mr. Fisher: No, we are not saying that. We feel that industry should have more of a voice in the kind of contribution made.

Senator Grosart: You are not saying that. You are saying that subsidies should be granted only when such research is recommended by industry. That would suggest that there should be no Government initiative because the word "only" means nobody else. Are you saying there should be no Government initiative in the industry sector in our national science policy?

Mr. Fisher: We are basically saying that we should have the support of the industry.

Senator Grosart: You are not saying support.

Mr. Fisher: I mean support from the standpoint of recommendations.

Senator Bourget: Mr. Fisher, your company has had experience with foreign government agencies. Can you tell us what the difference is between your relations with foreign agencies and your relations with Canadian agencies?

Mr. Fisher: I have had varying experiences, of course, depending upon the foreign agency that we have been working with. Maybe we could give you some examples. We have worked with BISRA, British Iron and Steel Research Association and we have found that a great deal of their effort is confined to the more pure areas, almost an academic approach to research. We can see, arising out of the various programs they are involved in, very little practical applied benefit that industry can assimilate and make use of. Another thing is the tendency on the part of BISRA to engage in these programs and then not really allow too much co-operative effort on the part of industry. We should like to work in a co-operative way with people, such as BISRA, in an individual effort where we could work with them on a particular problem that faces us as a company. Then we would gain the fruits of our effort in this area. The tendency of these government-sponsored agencies is to make available to everyone the result of this kind of effort. You may have put your money into it, but you only share in a minor way from the benefits.

We have also worked with Institut de Recherches de la Siderurgie Francaise, the French equivalent of BISRA. Again, this is a government-sponsored agency. We have found a much more practical approach to the situation within this company, because we can work in a co-operative way and we can benefit from licence arrangements from many co-operative efforts that may be applied between ourselves and IDRSF. There has been a different approach. They are more practical and there is a more applied benefit arising from IDRSF, but also we can work co-operatively and benefit more materially. Again, we feel that this overall approach, using government agencies as the main fulcrum for research and development, is not the way it should be done. We feel industry should be generated by industry and with the co-operation of government agencies.

Senator Carter: Do any of the government agencies have a way of getting over this confidentiality problem?

Mr. Fisher: In case of IDRSF, they are prepared to grant us a licence within Canada, and this is the fruit of a co-operative effort. At least we have control. We can grant licences and benefit from the royalties that may arise out of this co-operative effort. We find less tendency, for example, on the part of BISRA, to give us this kind of benefit. They want the benefit to be dissipated or to use the benefit themselves, with BISRA acquiring the royalty benefit.

Senator Haig: That is the same as our own thinking here.

Mr. Fisher: I would say so.

Senator Haig: Do these licences give you very wide latitude or are they restrictive?

Mr. Fisher: They are usually rather restrictive. IDRSF again is responsible to the various companies and government agencies that support them. They have a responsibility to make this information available. We can only isolate it from the standpoint that we are in Canada, and isolate it from the European Common Market communities where IDRSF operates.

Senator Haig: It gives you a little advantage of a competitor.

Mr. Fisher: That is right.

Senator Grosart: Mr. Chairman, my French is bad this morning: What does "Institut de Recherche en Sidérurgie Française" mean?

Mr. Fisher: Institute of Iron and Steel.

Senator Grosart: You learn something every day.

Senator Bourget: It is a good day for you to learn a little French. I should be celebrating with the chairman.

Senator Grosart: May I ask you a question arising out of one of your recommendations on page 2, paragraph (n)? You do not recommend the establishment of government-sponsored industry-wide research associations. Are you referring to any particular kind of existing association there, the provincial research institutes or the suggestion of research institutes or campuses and so on?

Mr. McKay: This is in reference to a type of organization such as BISRA. We would not wish to sponsor such an organization or have such an organization in Canada.

Senator Grosart: But you like to deal with them in France? You would not want them here.

Mr. McKay: No, sir.

Mr. Fisher: We deal with them in France, because we can make a contribution. We feel a different approach would be much more

effective in France as well as in Canada. In other words, we like industry to be involved directly rather than indirectly through the agency of IDRSF.

Mr. McKay: We have a choice in France. We can decide whether we will or will not associate with them, but in Canada would we have such a choice? You see the difficulty; it is a subtle one.

Senator Grosart: Would this rule out organizations such as the pulp and paper industry associations?

Mr. Fisher: That again is an industry association, not a government-sponsored agency. We say government-sponsored, industry-wide, the emphasis is on government-sponsored. We have the American Iron and Steel Institute which sponsors research and development programs and contributes to the overall effort and competitive situation of the industry. I think this is very desirable. We can concentrate on our own problems and give a better direction to the program, because we know more specifically where the maximum effort and priority should be.

Senator Grosart: In other words, you do not want cartels in Canada?

Mr. Fisher: No.

Senator Carter: Could I ask a question about relations with universities? They brought out this morning that communications between government and industry is not too good, particularly with reference to incentive programs. In both the Steel Company and the Aluminum Company briefs it is implied that there could be better relationships with the universities. Are you taking any initiative on your own to improve these relationships or are you just letting the universities go on "doing their thing" and you are "doing your thing" without either knowing what the other is doing or without there being very much interest in what the other one is doing?

Mr. Mason: We have had a number of examples, such as the chemical engineering staff visiting our big works. We invite them there for a symposium on some subject. In addition to that, we have given them specific projects in certain cases to work on. A third means is to invite them into our works for summer employment. We have had several professors come and spend the summer with us. We give them some jobs to do and ask them to give courses to our people. This means we are able to do some updating of our chemical engineering staff from the university people. At the same time, there is a cross fertilization, as I mentioned before, between the two, on ideas and techniques.

An example of that is that at McMaster they have been getting a whole section involved in the Bayer process for the extraction of aluminum from bauxite. This has been an extensive program, with 30 students and a number of members of the staff involved. They have spent several weeks on this problem and they have come back with what they feel is a good analysis of the process.

In doing this we feel we have sacrificed some confidentiality but we feel this is now probably worth the effort and we should not be too severe on this question of confidentiality.

We cannot have them work on the process without telling them how it works. We feel we must give them some precise detail, but they respect this. So far this has been very beneficial in working through the colleges at the present time, but I think there is room here for more activity in this regard.

Senator Carter: This has resulted from your own initiative?

Mr. Mason: Yes.

Senator Carter: I wonder if the other industries have felt the same way?

Mr. Fisher: To some extent our experience has been the same, but I do not think we have involved ourselves so much as Mr. Mason has. Industry has an increasing responsibility to involve itself more and more in the academic area. First of all, it is necessary to establish a better liaison, so that the universities and technical schools are more aware of the problems of industry and become engaged more and more in their effort, in the applied areas than in the pure areas. We think there is a need for a trend over to the applied areas.

We have been involved in specific problem areas, in going to the universities and establishing a co-operative program with the research facilities in the universities and engaging in the problem area.

We have done some, but we think we could do more and be a greater influence than we are, in endeavouring to exercise an influence in universities towards more applied effort in

research programs. And in teaching methods, too, we feel there is too much of a theoretical approach and that we are generating people in the graduate area who are not well oriented on these problems of industry and who are not as well assimilated in industry, as a result.

Senator Belisle: I refer to the University of Sudbury.

We have many of their men who were in Falconbridge, and we have a director there at the university.

Mr. Mason: Yes.

The Chairman: That does not mean closer liaison in the field of research.

Mr. Mason: You must have technical people talking to technical people about technical problems. You cannot go through the top level of the university. It must be at the technical level. This is where the benefit will accrue to them, when they have the actual contact, first on the plan and then in dealing with the process.

In the field of computers, the universities are very well qualified. They have qualified staff and lots of ideas on the use of computers. We have found it beneficial to use their machines and their technicians as a means of updating ourselves in these newer techniques.

This is an area where a very great change is taking place, in the simulation of processes and applying mathematical analysis to chemical processes. It is an area of rapid change and one where we can benefit by using their experience and they can benefit by having practical problems to deal with.

Senator Carter: And in making the universities more oriented towards industry.

Mr. Mason: Mr. Fisher made that point.

Senator Carter: The question in my mind is, is this something you think you should be doing totally on your own, or should the Government have a role there as well, or should the Government stay out of it?

Mr. Fisher: We have academic institutes, and the universities and technical schools also have a responsibility in this area. They could do more with respect to knowing what is going on within industry.

For example, there is the experience at Waterloo, where they have actually geared their technical programs to involve their students in industry outside, for a period. During their academic career, this is good, because they can get a practical approach and can become actually involved in industrial problems, and they apply their theory in a more practical way.

We think the university and the technical schools could do more of this, have more involvement. At the same time, we feel an increasing responsibility ourselves to influence the academic environment and endeavour to encourage this kind of research.

Senator Carter: This is something fairly new on the part of industry?

Mr. Fisher: Yes.

Senator Carter: There has not been any similar initiative on the part of the university? This initiative has come from industry?

Mr. Fisher: I do not think all of the initiative has come from industry. We have had university initiative on the use of computers and in suggesting programs to us. But this has been confined to one or two specific areas—Waterloo was one and McMaster was another—where they come to us and feel they can make a contribution and ask us to work with them.

Senator Carter: How can this be spread out to get the idea across to more industry and more universities, that this is what should be done?

Mr. Thomas: If I may speak for Dofasco, we have done some work with universities and in particular with McMaster. If you talk to the professor, it is felt you are competing against a government grant for research, which he can get on the one hand and which carries no restriction on the work, rather than ask him to work a specific program. So we are in competition for the tax dollar and that creates some difficulty.

Senator Bourget: Do you employ many students during the summer holidays to stir their interest?

Mr. Fisher: We do, to the maximum degree that we can assimilate them, and this has been done over the years. We have taken a large number of students and given priority to university students, because they normally are becoming involved in industry and business.

Mr. Laing: We have taken about 500.

Mr. Fisher: We have taken about the same.

Mr. Mason: Ours also has been about the same. These people are very good potential employees. They get to know the people in industry and they know the business we have. There is a very high yield of return on these people who have worked for us in the vacation.

Senator Bourget: What about Falconbridge?

Mr. Thornhill: About the same.

Senator Bourget: That is good.

Senator Kinnear: In regard to Waterloo University, we heard of the graduate class this year. They have 11 in it and 10 went to the United States. I wish to point out this also in the brief, in the last sentence, where you say "that the Canadian tax climate should be made sufficiently attractive that highly qualified people will be induced to remain in Canada in spite of the fact that for the foreseeable future employment opportunities will be more attractive in the U.S.A."

Also, on page 27, in the first sentence you say that we are "competing for available personnel with the U.S.A." A few sentences later you say you are convinced that "there is a serious loss of such people to the U.S.A."

This would suggest we are not competing too successfully in retaining our best research personnel and no doubt this will become more serious as the war in Vietnam ends. How serious is the problem? If we lose the brightest researchers to the United States, how can we build a first class innovative industry, and what is the solution?

Mr. Fisher: I would emphasize again that we feel we are losing some of our better trained talent to the United States and elsewhere, and there should be some effort to retain these people who have such high qualifications and such high potential.

I mentioned earlier—with my tongue in cheek—that it may be we could incent them by putting less of a penalty on them with respect to income in the income tax arrangements; but this segregates a very select group for this kind of treatment and it is indicated that this is a very difficult thing to do.

Really, it is the fact that they can go to the United States and secure better job opportunities, better potential for the future, a higher remuneration, and they can establish a higher standard of living for themselves and they have a better opportunity for advancement and there is also a diversification in the research and technical areas, in the standpoint of utilization of their talents, and there is a larger market for this kind of people, with greater opportunity all the way through.

We should give some thought to this and should try to develop within Canada a better opportunity for those people and more incentive to retain them.

Senator Bourget: Is there much difference between the salaries paid to scientists in Canada and the salaries paid to scientists in the United States?

Mr. Fisher: The difference is rather substantial.

Senator Bourget: Would it be between 20 and 25 per cent?

Mr. Fisher: Certainly in that order.

Senator Grosart: Mr. Chairman, I was inclined to be impressed with the case that the representatives of subsidiary companies in Canada made out for their contribution to Canadian research and development. However, I find a rather alarming statement on that matter on page 6 of the Dofasco statement.

> A closer look should be taken at the research money grants which are made to research departments run by foreign subsidiaries. In some cases, research establishments and pilot plants have been put into operation in Canada by foreign controlled companies for the development of processes which appear to be aimed at non-Canadian markets for exploitation without benefit to Canada.

Have there really been cases of research funding of foreign subsidiaries where the use of the products of those funds was without benefit to Canada? Do you know of any cases, Mr. Thomas?

Mr. Thomas: Unfortunately, this is not my comment and I cannot say.

Mr. Laing: When I asked the author of that particular section of our brief, he mentioned one case.

Senator Grosart: There was only one case? However, if this is widespread, it is a very serious criticism of our whole funding of research. But you don't think it is a widespread criticism of the research funding?

Mr. Laing: No.

The Chairman: I suppose that these projects would not be eligible on most of our incentive programs, but perhaps they might be eligible for grants from NRC.

Mr. Laing: Do you mean that they would not be eligible because they would not be exploited in Canada? I cannot speak to that.

Mr. Darby: Mr. Chairman, that is why we suggest tax incentives. You have either to make capital investments in Canada or to generate taxable income in Canada. A foreign company could not do its research through Canadian subsidiaries and take benefit of that and exploit it in the United States, for example.

Senator Grosart: Well, the point I am getting at is that this is without benefit to Canada.

Mr. Darby: What I am saying, though, is the fact that, if you hang your incentive on tax incentives and have either a more rapid write-off of capital investment facilities in Canada or a lower tax rate on taxable income generated in this country, then Canadians and the Canadian economy will benefit. It does not prohibit the United States economy from benefitting at the same time. Of course, we get tremendous advantage from research done all through the world.

Senator Grosart: I am not objecting to the development of products that can be exploited in a foreign market. That is the name of the game.

Senator Kinnear: Mr. Chairman, this is an open question. Do you get many of your researchers from Europe?

Mr. Fisher: We do.

Mr. Thomas: Yes.

Mr. Thornhill: Yes, we do.

Senator Kinnear: So all of you do. In that case, there seems to be rather a paradox here, because on the one hand we are told that the situation in Canada is that there are highly-trained scientists and engineers graduating from our universities every year and yet we are told by the industrial companies that they cannot easily obtain the staffs they need. What is the cause of this shortage in the midst of plenty? For example, we heard the other day of somebody advertising for researchers or scientists, and out of 20 they could only use two. Do you people find any difficulty in this respect?

Mr. Fisher: One point I should emphasize is that we are not just looking for bodies; we are looking for people with talent and potential.

Senator Kinnear: That is what I am speaking of—very highly-trained scientists.

Mr. Fisher: We feel we are losing a tremendous number of the good people to the United States where, to some extent, opportunity is greater for these particular people with their peculiar talents.

Senator Kinnear: Do you mean you cannot use them here?

Mr. Fisher: We can and would like to, but we are losing them. We cannot establish sufficient incentives to retain them under our economy and with our income tax situation and other factors. Again, I mention the diversity of opportunity in the United States that we cannot possibly generate within the confinements of our economy.

The Chairman: So we import from Great Britain and export to the United States.

Mr. Fisher: We import not only from Great Britain but also from Europe.

Senator Kinnear: And are the people who come from Europe also going to the United States?

Mr. Fisher: We are more likely to retain them.

The Chairman: They go to the United States, if they are good enough.

Senator Kinnear: It seems to me that Canada is in the squeeze.

Senator Bourget: Are the scientists coming from Europe better qualified than those who are produced by our own universities?

Mr. Fisher: They are better than the ones we are able to retain from our own universities, otherwise we would not be hiring this particular element. But because they meet our requirements in the research area, which requires a very high degree of training and technical skill and potential from the standpoint of innovation, we do hire these Europeans. We are looking for a particular faculty within the individual. We may be a very energetic fellow, but he may not have the innovative approach and we may not be able

to use the particular routine skills or training he has. It is a particular element in the technical community that we are looking for—the element that we can use in developing research and development programs, and the ideal people who can then take their ideas and begin a practical application of the ideas in the development and research programs are the ones we are looking for. If we find this element in a European and cannot get the equivalent skills in a Canadian, naturally we are going to hire the European.

Another thing is that the European is more likely to come to us based on what we can offer. The Canadian with similar skills can be offered something substantially higher in the United States.

The Chairman: What is the proportion of Europeans on your staff?

Mr. McKay: There are about 80 people in the research department. I would be rather hard pressed to say what the exact percentage is of European origin or Asiatic origin.

Senator Kinnear: How many Canadians do you have?

Mr. McKay: I don't know.

Senator Kinnear: That is odd.

Mr. McKay: I can say, though, that we have had a great influx of Czechoslovakians recently, much to our advantage. But you have to maintain a balance in your staff. I should like to think our staff was predominantly Canadian, and I should hate to think that some time in the future we would be of more foreign origin in our staff than of Canadian.

Senator Bourget: Are these scientists coming from industry or from universities?

Mr. McKay: From industry.

Senator Bourget: Should there be, then, some changes in our university courses? Because we have been told that there is too much basic research and that they are not prepared to face that kind of research that industry needs.

Mr. Fisher: There is a lot of truth in that. A lot of work going on in training and research work in universities is not in the applied areas, and we certainly take issue with that. I have a case in point. I visited Japan last fall and visited some of the research institutes within the university environment. They were doing a lot of research work there and I found that there was a closer liaison and a much higher proportion of research that could specifically be taken advantage of in industry itself. There was a very close-knit co-operative effort between the universities and industry and we see the fruits of that kind of effort in what the Japanese are doing today and the kinds of innovation they are coming up with. I think this same kind of approach if a co-operative effort which to some degree is engendered and encouraged by the Japanese government could be applied here.

First of all, the government itself on a broad basis is working very closely with the university and industrial environment to bring this co-operative effort towards certain national goals to encourage those in the export market area to come up with new and better products, more competitive products, and to produce them at a lower cost. This is almost the national objective. They encourage the universities to engage in applied research and to carry on a close liaison with industry in this regard. There you find there is a very close meshing of the university effort with the industry effort which does not exist here.

Senator Bourget: So that in Japan you have some kind of research institute on campus in the universities to encourage more practical experience in development and in innovation.

Mr. Fisher: The very fact that they have these programs going on in the university environment means that people engaged in it will have greater knowledge not only of the practical approach but also they will know what industry is doing and what their objects are. We think there is a need for more of this in our own academic environment.

Senator Bourget: They have more scientists working in industry?

Mr. Fisher: And they have more people with a university education in industry in Japan than we have here.

The Chairman: They have fewer in government labs than we have here proportionately.

Senator Blois: Mr. Chairman, there is one point I wish to raise which is clear to me but which I am afraid may not be clear to members of the committee. I am speaking now on the point of scientists coming to Canada from

other countries. I rather feel that the proper answer to that is that the people they are bringing in are people that not only have knowledge and training but who also have considerable practical experience. These people can get better wages here in Canada and they have this considerable training and experience. Speaking now from some practical experience in have had in these matters, I think this should be made clear.

The Chairman: I think this point has been brought up by Mr. McKay a few minutes ago.

Senator Bourget: I have another question to ask, Mr. Chairman, in connection with information services. Do the witnesses recommend one centralized clearing house for scientific information or would they prefer the establishment of centres of information spread in different parts of Canada? I am directing this question to all of the witnesses.

Mr. Fisher: I do not see anything wrong with a central source of information as long as it functions well, is up to date and made readily available.

The Chairman: Have you seen the Tyas study published recently?

Mr. McKay: Yes, and I have discussed it with the people in the National Science Library and we have nothing but praise for what they are attempting to do. It is very impressive and we wish them the best of luck, and we hope the government will get behind them and make sure the programs they now have planned will come to fruition.

Senator Bourget: You are satisfied with that?

Mr. McKay: Very satisfied.

Mr. Mason: I would agree too.

Mr. Thornhill: I agree.

Mr. Thomas: I find it a very good service.

The Chairman: Honourable senators, on this note of unanimity we will adjourn. I thank our guests for this most interesting discussion we have had this morning.

The committee adjourned.

APPENDIX 171

BRIEF SUBMITTED TO

THE SENATE SPECIAL COMMITTEE ON

SCIENCE POLICY

BY

DOMINION FOUNDRIES AND STEEL LTD HAMILTON

SUBMISSION OF

DOMINION FOUNDRIES and STEEL, LIMITED
HAMILTON - ONTARIO

TO THE SPECIAL COMMITTEE ON SCIENCE POLICY

OF THE SENATE OF CANADA

The Special Committee was appointed to consider and report on the science policy of the Federal Government. This submission will deal with one of the points listed in the Order of Reference of the Special Committee, namely federal assistance to research and development activities carried out by industry in the field of physical sciences.

Dominion Foundries and Steel, Limited is a fully integrated steel mill with interests in two iron ore mines in Canada, and with blast furnaces, oxygen steel making furnaces, hot rolling mills, cold rolling mills, galvanizing lines, tinning lines, other flat rolled steel finishing facilities and a foundry. A subsidiary company, National Steel Car Corporation Limited, manufactures railway rolling stock. The number of employees of Dofasco and National is about 7, 800. The annual sales are about $280 million.

Our brief takes the form of comments on the list of questions received as Appendix I to the letter of January 20, 1969, from The Honourable Maurice Lamontagne, in which we were invited to submit a brief.

A. FINANCING INDUSTRIAL RESEARCH

Question 1 — How best can the Federal Government encourage fruitful R and D in Canadian industry? Are present schemes satisfactory?

Comments on Question 1

The present schemes to encourage research in industry are:

(a) grants under the Industrial Research and Development Incentives Act;

(b) loans under the Program for Advancement of Industrial Technology;

(c) grants under the Industrial Research Assistance Program administered by the National Research Council;

(d) sharing of development costs under the Defence Development Sharing Program administered by the Department of Industry;

(e) grants under the Defence Industrial Research Program administered by the Defence Research Board.

We have made applications for grants under the Industrial Research and Development Incentives Act for research expenditures for 1967 as a continuation of the claim for the additional allowance under the Income Tax Act. We have made one application for a loan under the Program for Advancement of Industrial Technology ourselves and participated in an application in another project with two other companies. We have not made application under any of the other programs.

We have found difficulty in attempting to explain the nature of what we consider to be our research and development activities to the Department of National Revenue and the National Research Council. The difficulty is that we regard the experimental aspect of any innovation in our production process to be research and development, whether it is something that results from our own basic or applied research or results from adaptation to our particular needs of a process in operation somewhere else.

Our attitude toward the Program for Advancement of Industrial Technology is that we might want to use it where there is a high degree of risk that a proposed research and development project will fail. We understand that the interaction of the grants under the Industrial Research and Development Incentives Act and the loans under the Program for Advancement of Industrial Technology results in an effective net cost to a company of 12-1/2¢ on the dollar for research and development that fails and of 25¢ on the dollar

for successful research. The net cost of successful research where grants under only the Industrial Research and Development Incentives Act are received is also 25¢ on the dollar. This is the only reason that persuades us to use the Program for Advancement of Industrial Technology. The fact that funds are made available to finance half of the cost of the project while it is under way is not an inducement to us to use the program. We understand that a project which qualifies under the Program for Advancement of Industrial Technology qualifies also under the Industrial Research and Development Incentives Act. It is for this reason that the net cost to us of successful projects is the same whether or not we receive assistance under the Program for Advancement of Industrial Technology.

How the incentives are applied could be changed as follows:

During a recent review of our request for a grant under the Industrial Research and Development Incentives Act based on our 1967 expenditures, a representative of the Department of Industry told us that special purpose equipment imported for use on a research project the cost of which is included in current expenditures, does not qualify for a grant. If we purchased it through a resident company or a broker it would qualify and it is probable the purchase price would be higher than if we were to purchase it directly.

There is an illogical application of this rule. The rule applies to imported special purpose equipment, the cost of which is included in current expenditures. The rule does not apply to imported general purpose research equipment whose cost is included in capital expenditures. These capital expenditures qualify for a grant.

The distinction of where the equipment is purchased is irrelevant as a criterion for deciding on government support for research in Canada. The relevant criterion is where the research is done for which the equipment is purchased. We suggest that this administrative rule be dropped.

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of the Senate of Canada

Question 2 What federal assistance would help stimulate more innovation in Canadian industry?

Comments on Question 2

The present kinds of programs are adequate for this purpose with one change. The assistance provided under the Industrial Research and Development Incentives Act could be broadened to include development work which is for the purpose of improving processes. We understand from the definitions and interpretation that development work qualifies that meets two tests: first, that it uses the results of basic or applied research and; second, that there must be present a significant element of scientific or technical novelty or innovation.

With regard to the first test, we think development work for process improvement should be encouraged whether or not it uses the results of basic or applied research. Such development work includes that originating with suggestions from employees under suggestion award programs. It includes development work undertaken by operating department personnel and development work done in quality control laboratories and in engineering departments. This development work is not preceded by basic or applied research. It does benefit industry. It is a source of innovation which merits stimulation as much as innovation which originates from basic and applied research.

Added incentive might be given to inventors with possibly some system being set up whereby an inventor could be put in direct contact with those who could best use his invention in Canada. This might be done under the Department of Industry.

Question 3 How can federal agencies and departments, National Research Council for instance, more effectively assist Canadian industry?

Comments on Question 3

There does not appear to be an easy way except by way of good example,

or cases where federal agencies and National Research Council can be proven to have helped industry, the more mutual respect and interest will be generated.

Question 4 Is there a proper balance between the support of the federal government given the three sectors: industry, universities and federal government?

Comments on Question 4

The total of capital and current expenditures by the Federal Government on research and development and other scientific activities other than Department of National Defence was $373, 371, 000 in 1966-67. The current expenditures portion of this is $260, 069, 000. Of this, the part administered by the Department of Industry is $31 million. The part of the National Research Council expenditures for which industry is listed as the area of application is $11, 600, 000. An opinion of whether or not this proportion spent for industry ($42, 600, 000 of $260, 069, 000) is appropriate would depend on the benefits to Canada from the research done for the Departments of Agriculture, Fisheries and other departments and Atomic Energy compared with benefits to Canada from the research done for industry. If, to the amount spent directly for industry of $42, 600, 000 is added a benefit to industry from research in the Departments of Transport and in Atomic Energy, then the proportion spent for industry does not appear to be as high as it should be. It is likely that there would be earlier practical application from research work for industry which is a strong justification for allocating for industry a relatively high proportion of government financed research.

Federal Government current expenditures on research and development in 1966-67, including the Department of National Defence, were $328, 400, 000. An analysis of this shows that the performing organization is Canadian industry for $71, 600, 000 and educational institutions and individuals at such institutions for $50 million. The total includes spending by the Departments of Agriculture, Fisheries and other departments not related to industry. The proportion of federally financed research performed by industry by this

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Question 5 On the basis of your experience what is the appropriate creation of and balance between basic research, applied research and development?

Comments on Question 5

Generally speaking, it has been well established that far too much of the available scientific-minded time and effort is spent on basic research done in both the universities and government agencies. Direction should be given to ensure that more time is spent on applied research and development especially aimed at putting the new technologies to work in developing the manufacturing end of Canadian industry.

Question 6 What criteria should the federal government use in allocating funds to scientific activities such as the support of R and D in industry?

Comments on Question 6

Emphasis should be placed on devoting maximum interest and support to those projectswhich will increase our manufacturing of secondary goods which require higher skills and which produce a higher percentage return than we get in the exploitation of our primary resources. A closer look should be taken at the research money grants which are made to research departments run by foreign subsidiaries. In some cases, research establishments and pilot plants have been put into operation in Canada by foreign controlled companies for the development of processes which appear to be aimed at non-Canadian markets for exploitation without benefit to Canada.

Question 7 What changes should be made in federal government financial support of Canadian scientific activities?

Comments on Question 7

Perhaps requests for financial aid to Canadian scientific activities should be rated with a preferential lean towards those which will improve Canada's balance of payments by reducing Canada's dependence on imports and by generating foreign markets.

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of the Senate of Canada

B. INDUSTRY AND ITS ENVIRONMENT

Question 1 How can Canadian universities and industry more effectively collaborate in the field of science and technology?

Comments on Question 1

Serious attempts have been made by a number of engineering schools to improve communication between the university and industry. From industry's point of view, it appears that the universities lack a practical approach to the application of science to industry and overall scientific problems. It would be recommended that somehow the university scientific personnel must be exposed to industrial dollar and cents thinking and this can only be done with the co-operation of industry.

The universities and colleges must continue their efforts to make industrial people aware of what they have to offer and this will require a long hard sell.

Question 2 Do Canadian universities graduate scientists and engineers able to perform effectively in Canadian industry?

Comments on Question 2

While Canadian universities graduate scientists and engineers skilled in their respective disciplines, they lack a broad knowledge which would result from a well-rounded education. Graduates need improvement in the following areas:

1. Communications - the effective use of basic English - especially in written reports.
2. Problem-solving - the development of a good analytical approach to problems.
3. Economic realities - the need to relate scientific learning to dollar costs.

Question 3 What should the important long term goals of Canadian science be?

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Comments on Question 3

Simply stated, we must develop the best educational systems aimed at producing graduates in the scientific fields most requited by Canadian industry. Overall, there must be a shift towards applied research and development expenditures aimed at promoting Canada's secondary manufacturing industry. Increasingly, industry must assume its rightful burden of hiring and using more technical personnel following the example of the Japanese who have been extremely successful at applying and using new technology.

Question 4 Is there an adequate supply of scientific manpower in Canada?

Comments on Question 4

If it were not for the "exporting" of brains to the United States, we would probably have an adequate supply of scientific manpower. The challenge then is to provide meaningful work and incentive for Canadian engineering and scientific graduates.

Question 5 Does foreign ownership hamper the development of innovation in Canadian industry?

Comments on Question 5

In many cases, a Canadian subsidiary of an American company does no research in Canada, but still pays for its share of research carried out in the United States. One is probably safe in saying that in many cases the amount paid could support a very considerable Canadian research effort on the part of the subsidiary.

Question 6 Are the results of foreign science and technology available to Canadian industry in a timely and suitable manner?

Comments on Question 6

We think the answer to this is yes. We have good science libraries and through various Canadian and foreign technical societies, it is possible to get the latest up-to-date information on any subject which has in any way been made public.

APPENDIX 172

BRIEF

BY

THE STEEL COMPANY OF CANADA, LIMITED

TO

THE SENATE OF CANADA

SPECIAL COMMITTEE ON SCIENCE POLICY

I N D E X

1. Summary of Recommendations

(a) The aim of government science policy should be to encourage research and development in the private sector which will assist in maintaining or increasing the prosperity of the economy by making Canadian industry more efficient and competitive, for example, by improving its productivity and the quality of its products or by developing new products.

(b) Government should encourage business to engage in research and development along lines of its own choosing.

(c) Government should provide incentive programmes to encourage industry in Canada to engage in research and development.

(d) Government incentive programmes should, preferably, take the form of tax concessions rather than grants or subsidies.

(e) Tax incentives should apply to all research and development expenses and not merely the excess over some base period even if this involves lowering the percentage benefit.

(f) For tax incentive purposes, the definition of capital expenditures for research should include the first commercial facility utilizing the results of research.

(g) Consideration should be given to an additional incentive applicable in the initial years of operation of a new project.

(h) Administration of government incentive programmes should be centralized, simplified and standardized.

(i) Some reasonable assurance should be given of continuity in government incentive programmes.

(j) A single publication should be prepared outlining government incentive programmes and applicable administrative procedures.

(k) In government incentive programmes, the definition of eligible expenditures should be drafted in such a way as to minimize problems of determining eligibility and to avoid the necessity of disclosing confidential information.

(l) Government research agencies should consult with industry in choosing research programmes and scheduling the use of their facilities.

(m) Joint government-industry research projects should be conducted on a basis which will ensure that discoveries will be kept confidential if the participating businesses so require.

(n) The establishment of government-sponsored, industry-wide research associations is not recommended.

(o) The government should provide centralized clearing houses for scientific information.

(p) The facilities of the National Science Library should be expanded to provide broader service.

(q) The facilities and retrieval system of the Canadian Patent Office should be improved especially to facilitate the examination of Canadian patent art.

(r) The Technical Information Service should be improved along the lines of the United Kingdom Technical Information and Library Services Reports Centre of the Ministry of Technology and of the U.S. National Referral Centre for Science and Technology, Library of Congress.

(s) Government employees responsible for disseminating technical information should be given opportunities to study appropriate segments of Canadian industry.

(t) Governments and universities should encourage university staff to become more oriented toward Canadian industry.

(u) Government should revise its tax policy to establish a tax climate which would encourage highly qualified people to remain in Canada instead of emigrating to the U.S.A.

2. <u>Terms of Reference</u>

This brief is submitted to the Special Senate Committee on Science Policy in response to the invitation of the Chairman of the Committee contained in a letter dated January 20, 1969, and addressed to the President of this Company.

It is our understanding that the Committee is engaged in an extensive inquiry into science policy in Canada based on the Order of Reference under which it was appointed which directs the Committee to consider, and report on the science policy of the Federal Government with the object of appraising its priorities, its budget and its efficiency in the light of the experience of other industrialized countries and of the requirements of the new scientific age and, without restricting the generality of the foregoing, to inquire into and report upon the following:

(a) recent trends in research and development expenditures in Canada as compared with those in other industrialized countries;

(b) research and development activities carried out by the Federal Government in the fields of physical, life and human sciences;

(c) federal assistance to research and development activities carried out by individuals, universities, industry and other groups in the three scientific fields mentioned above; and

(d) the broad principles, the long-term financial requirements and the structural organization of a dynamic and efficient science policy for Canada.

While the Order of Reference includes within its scope the fields of "physical, life and human sciences", this brief will be restricted to the physical sciences.

3. The Company and its Research Activities

(a) Description of the Company

The Steel Company of Canada, Limited is the largest basic steel producer in Canada with over 40% of Canadian steelmaking capacity. The Company has eighteen plants located in four provinces and has sales officed located in every province except P.E.I. It has iron ore mines in Newfoundland, Quebec and Ontario. In 1968, the Company has sales of $589,612,742. It employed an average of 21,584 employees during 1968 and at the year-end had 52,520 shareholders approximately 95% of whom were Canadian. The Company is, therefore, one of the largest and most important industrial corporations in the country and represents a distinctively Canadian point of view.

(b) Description of the Company's Research Activities

The Company has for many years been active in research and development related to the steel industry and has endeavoured, we believe successfully, to keep in the forefront of technology and innovation in this field through its internal research programmes, utilization of facilities of government departments and agencies, both domestic and foreign, co-operation with other companies and close ties with the academic community.

(i) Internal

Internally, various department of the Company have been active in developing improved technology, equipment and products. The Company has been a world leader for many years in blast furnace technology; it was one of the first to make extensive use of oxygen in steelmaking; it invented the Stelmor Process for the production of wire rod which does not require special heat treating; it has been a leader in the direct reduction of iron ore and in a new approach to steelmaking based on the use of such reduced ore in electric arc furnaces; and it developed a unique process for making spiral nails without twisting. These are merely examples of the type of research and development in which the Company is continuously engaged.

By the 1960's the Company concluded that the accelerated rate of technological change in the iron and steel industry made desirable a more highly organized and sustained programme of investigation and research. Accordingly, a Research Department was set up in 1962 and a Research Centre was completed in 1967 at a cost of $4.5 million to be devoted to applied research in iron and steel manufacture and technology. This Centre compares favourable in the quality of

its personnel and facilities with any in the world although its size is of necessity smaller than facilities operated by larger steel companies in countries such as the U.S.A. and Japan.

(ii) External

In addition to its internal research activities, the Company has engaged in co-operative research with a variety of public and private agencies both domestic and foreign and accordingly has considerable familiarity with the available opportunities for such work.

(aa) Relations with Canadian government agencies

The Company participated in research projects in co-operation with various government or government sponsored departments, agencies and associations including the following:

Department of Energy, Mines and Resources
Canadian Carbonization Research Association
Solids Pipeline Research and Development Association
Solids Pipeline Economic Study Association
Canadian Zinc and Lead Research Committee
Canadian Continuous Steel Casting Research Group
Eldorado Mining and Refining Corporation and various industrial research institutes.

We are, therefore, familiar with the type of direct assistance which can be provided by government agencies in Canada.

(bb) Relations with foreign government agencies

The Company is also familiar with similar types of assistance available in other countries through its participation in research projects in co-operation with the following bodies:

British Iron and Steel Research Association
Institute de Recherches de la Siderurgie Francaise
Centre National de Recherches Metallurgiques (Belgium)
Association Internationale pour les Recherches de Base au Haut Fourneau d'Ougree
U.S. Bureau of Mines
Blast Furnace Research, Inc.

(cc) Relations with industry associations and other companies

The Company participates actively in the technical committees of numerous industry associations and has made use of various commercial research institutes including:

Ontario Research Foundation
Illinois Institute of Technology
Battelle Memorial Institute
American Iron and Steel Institute
and sundry similar trade organizations.

In addition, we have from time to time made arrangements with other companies for the joint development of promising projects. For example, we are the leading participant in a group of companies which is conducting research on the direct reduction of iron ore and other ores and the utilization of reduced ore in electric arc furnaces. This group includes U.S. and German participants.

(dd) Relations with universities

The Company appreciates the importance of close ties between industry and the academic community and the necessity of providing assistance to universities with a view to encouraging research and assisting worthy students. In this connection, we have established a Chair in Metallurgy at McMaster University, have contracted projects with the University of Waterloo Industrial Research Institute and have established a student aid programme which provides graduate research fellowships in metallurgy and a variety of scholarships, bursaries and awards in technology. In addition, the Company has sponsored various research projects at different universities.

(c) Expenditures on Research

The extent of the Company's interest in research is indicated by the fact that its direct expenditures for this purpose in the last seven years totalled $20,500,000. This, of course, does not include its student aid programme or expenditures on development which would be absorbed in operating expenses.

(d) Extent of Government Assistance

The importance of government assistance in carrying through this programme is indicated by the fact that for the same period deductions in determining taxable income totalling $26,200,000. were made in respect of research under Sections 72 and 72A of The Income Tax Act. In addition, grants totalling $79,000. will be claimed under the Industrial Research and Development Incentives Act by the end of the 1968 taxation year.

4. Aims of Government Science Policy

(a) Aims of Policy

Before any meaningful evaluation of present government policies can be made or any useful recommendations put forward, it is necessary to state the standpoint from which we view this problem. We must determine what the aims of science policy should be before attempting to decide what means are best calculated to achieve these ends. In attempting such a formulation, we recognize that it is

impossible to achieve everything all at once. Priorites must be established. In a country like Canada with a small population, limited financial resources and very high levels of taxation, it is obvious that government support for research must be directed towards those areas which will produce tangible results without too long a delay.

Under these circumstances, we suggest that the aim of government science policy should be to encourage research and development in the private sector which will assist in maintaining or increasing the prosperity of the economy by making Canadian industry more efficient and competitive, for example, by improving its productivity and the quality of its products or by developing new products and processes.

(b) Means of Achieving this Aim

To achieve this aim, the means employed by government in implementing its science policy must,

(i) recognize the demands of the market in a manner flexible enough to meet the continuous changes in the market; and

(ii) encourage the utilization by industry of the results of research.

In our view the most effective government science policy is one which encourages industry to engage in research along lines of its own choosing with as little government direction or interference as possible. Direct government

involvement in research should be directed primarily toward those broad areas such as energy resources and development of the north which may be beyond the capacity of any single industrial enterprise and in education and the dissemination of information. Accordingly, we would oppose the appointment of a minister responsible for science or technology or the formation of a department to deal with these matters. The problem will not be solved by direct government involvement in research except in specific areas as indicated above.

Perhaps the most important means which can be adopted by government for achieving the ends in view is an indirect one involving the creation of an economic climate which rewards initiative and risk-taking. It is often difficult to reduce promising discoveries to practice because of the risk involved and the amount of capital required. Government policy should, therefore, be directed toward creating a climate favourable to the entrepreneurial spirit, risk-taking and the formation of the necessary pools of venture capital.

In general, therefore, we recommend that government science policy should encourage research and development in Canada by the following means:

(i) encouraging business to engage in research by granting adequate tax concessions with respect to research expenditures;

(ii) providing government-owned research facilities and programmes and preferably granting subsidies only when such research is recommended by industry and is beyond the capacity of industry;

(iii) encouraging a closer relationship between the academic community and industry especially when research is being carried on under academic sponsorship; and

(iv) revising its taxation policies by making rates of personal income tax, gift tax and estate tax more attractive than those in the U.S.A. in order to encourage talented and experienced people to remain in Canada.

These recommendations will be developed in more detail hereunder.

5. Evaluation of Existing Government Programmes

(a) Government Incentive Programmes

(i) Outline of Existing Programmes

The five government incentive programmes currently available in respect of research and development are outlined in Schedule A hereto. This Company has had experience under PAIT and IRDIA as well as under Section 72A of the Income Tax Act. We have not made use of IRAP, DDSP and DIR and cannot comment on their effectiveness.

SUMMARY OF FIVE COMPLEMENTARY GOVERNMENT INCENTIVE PROGRAMS

Assistance Program	Objective	Program Administered by	Nature of Incentive	Date Introduced
Defence Development Sharing Program (DDSP)	"To sustain and improve the development capabilities of Canadian companies active in the military product field"	Dept. of Industry Trade and Commerce	Costs shared. Government share not repayable	1959
Defence Industrial Research Program (DIR)	"To improve the ability of Canadian companies to compete for research, development and ultimately production contracts in the United States and NATO defence markets"	Defence Research Board	Costs shared equally. Government retains royalty-free right of use	1961
Industrial Research Assistance Program (IRAP)	"To create new research facilities within industrial companies and to expand existing facilities" and "to improve communications between research workers in government and industrial laboratories"	National Research Council	Payment of the salaries of new research teams in companies where none previously existed, or for new research workers to be added to existing research staffs over and above a company's normal expansion of research effort. Support extends from 3 to 5 years by annual grant, subject only to satisfactory progress	1962
Program for the Advancement of Industrial Technology (PAIT)	"To help industry help itself to upgrade its technology and to expand its innovation activity by underwriting specific development projects which involve a significant technical advance and which offer good prospects for commercial exploitation"	Dept. of Industry Trade and Commerce	Cost of an improved development project shared equally by the Department and the company concerned. If the results of the development project are put into commercial use, the company must pay back within ten years the Department's contribution together with compound interest based on the government borrowing rate	1965
Industrial Research and Development Incentives Act (IRDIA)	"To provide general incentives to industry for the expansion of scientific research and development in Canada"	Dept. of Industry Trade and Commerce	Grants equal to 25 percent of the aggregate of a company's capital expenditures and any increase in current expenditures during the fiscal period over the average of the preceding five fiscal periods	1967

It may be that there are special considerations applicable to defence research which merit its being treated in a manner different from research in other fields. Accordingly, our discussion of government incentive programmes will exclude any reference to this area.

(ii) Comment on Existing Programmes and Recommendations

Our overriding comment on government incentive programmes is that such programmes provide the most effective means for the encouragement of research and development in Canada within the limits of available funds. Without such encouragement, for example, it is doubtful if this Company would have built its Research Centre or have carried through some of its more costly and effective research programmes.

This is not to say, however, that the present programmes constitute the best conceivable means of attaining the desired end. As noted above, the ultimate aim of government policy should be to encourage research and development work which will increase national prosperity. This implies that the results of such research should be commercially exploited. IRDIA proceeds on the assumption that, if industry is encouraged to spend money on research, the desired result should follow. This assumption is valid to the extent that industry is not interested in research for the sake of research and would not engage in it unless it

anticipated that it could be commercially exploited. PAIT, however, goes further and recognizes that some additional encouragement may be necessary in order to ensure that research will be directed along exploitable lines. The idea behind PAIT is sound, but this Company, and presumably others, hesitate except as a last resort to use the programme because of the administrative detail demanded in advance of project approval or in withdrawing from a project, the necessity for full disclosure of results to government employees, and the stipulation that results be exploited within a reasonable period of time in Canada. Industry prefers to be flexible in its approach to research projects, to treat the results as confidential and to exploit them when and where the economic considerations dictate. The PAIT programme does not fit well into our view of how research should be conducted. It would be more desirable to encourage the exploitation of research findings by granting tax concessions in the manner recommended hereunder.

Somewhat the same comments apply to IRDIA to a more limited extent. We believe that tax incentives which encourage a taxpayer to increase his profits provide a more effective and flexible means of

promoting the practical application of scientific knowledge than do grants or subsidies. Similarly in the case of research carried out in Canada by foreign-owned corporations, the benefit of tax incentives would be available only if there was accompanying commercial activity in Canada. For these reasons we consider that the scheme of Section 72A of the Income Tax Act was preferable to the IRDIA programme although there were objections to that legislation relating to the use of a base period.

We recognize that it is argued in some quarters that a system of grants or subsidies is preferable to one of tax incentives since it permits participation in the programme by companies which do not have profits sufficiently large to permit them to take advantage of such incentives. It is our impression that the number of such cases must be very small and we find it difficult to see how an unprofitable company could be expected to undertake an effective research programme in view of the large expense and high risk involved. This problem is mitigated by the present income tax provisions permitting a carry-over of business losses. In general, however, we submit that research and its commercial exploitation should be encouraged by making it more attractive taxwise rather than having

government become a partner in research. In our view the only case where there is an argument for direct government participation in research programmes is in the case of very costly and risky programmes which are clearly of value to Canadian industry but are beyond the capacity of industry to carry out itself, such as research with respect to solids pipelines. Even in such cases, it is important that the government minimize the administrative difficulties involved in its participation in such programmes.

Our objection to both Section 72A of the Income Tax Act and the IRDIA programme is to the provisions of incentives only with respect to expenditures in excess of those in some base period. This system discriminates against those taxpayers who showed sufficient initiative to engage in research before incentives were available, who took early advantage of such incentives or who made large expenditures during the base period. We suggest that your Committee should be concerned that government incentives should be not merely effective but equitable and non-discriminatory. In fact, it may well be that the objectives of the legislation are not being achieved because of this discriminatory

feature. For example, we believe that there could be cases in which research is discontinued or curtailed following high expense years so as to establish a lower base period for the future. It is unfortunate that government policy should produce such disruptions and distortions. We would recommend abandoning the base period even if this involved lowering the incentive rate.

In connection with any plan whether in the form of tax incentives or grants, we recommend that the definition of capital expenditures for research should include the first commercial facility utilizing the results of research as well as those capital items directly involved in research. Such a provision should shorten the time gap between discovery and exploitation. The final steps required to put into commercial operation discoveries made by research are frequently the most expensive and involve the greatest risk. A discovery may be allowed to remain at the applied research stage simply because of the financial risk involved in scaling-up a process or perfecting a product prior to commercial exploitation.

If the Canadian economy is to realize the maximum benefit from research and development, consideration should be given to an additional incentive in the initial years of operation of a new

project. We have no precise formula to suggest but this might be in the nature of an easing of the tax rate for a limited period on profits derived from new products or processes resulting from research work performed in Canada.

Our experience also leads us to the opinion that the government incentive programme has been unnecessarily complicated by the creation of a number of plans to meet a variety of situations, their administration by a number of different departments and agencies, and their frequent revision or discontinuation. It is our view that optimum use of incentives by industry has been discouraged by administrative complications of information and uncertainty. In addition, the cost of administering the various programmes both in government and industry must be greater than if the system were simplified. While it may not be possible to devise a single incentive system, it should be possible to simplify and rationalize the present situation. In addition, because of risk involved in research programmes, businessmen are reluctant to commit themselves without some assurance of continuity. We would, therefore, recommend that, so far as possible, government incentive programmes be consolidated and administered through a single agency, or at least have common application

and submission procedures. It might also be helpful if a single publication were available outlining the various programmes and the administrative procedures applicable to each. The definition of eligible expenditures should be drafted in such a way as to permit businessmen to determine the eligibility of projects with a minimum of difficulty, and particularly without having to disclose confidential information.

(b) Government Research Agencies

(i) List of Existing Agencies

A variety of governmental departments and agencies in Canada are engaged in research activities. These include:

Defence Research Board
Department of Energy, Mines and Resources
National Research Council
various provincial institutes or councils.

In addition, government bodies from time to time sponsor or participate with industry in associations of various kinds related to specific areas of research such as:

Canadian Carbonization Research Association
Solids Pipeline Research & Development Association.

(ii) Comment on these Agencies and Recommendations

In general, our relations with such bodies have been satisfactory. It is our view that, if the services of government agencies are to promote

effectively the aims of science policy outlined above, it is important that they be aimed at objectives which may be exploited commercially and for this purpose that industry have a voice where practicable in the research programme to be pursued and the scheduling of the use of available equipment. This conclusion has been borne out in our relations with research associations sponsored by or using the facilities of foreign governments.

Another important consideration in any such co-operative ventures is that government bodies should appreciate the importance to industry of treating discoveries as confidential if government facilities are to be used to the best advantage by industry. In some cases, we have encountered situations, especially in the U.S.A., where the policy of government agencies seems to be directed to immediate publication of results and to making such discoveries available to all and sundry at nominal cost. Such policy is contrary to the interest of participating companies which may have made large contributions of money, time and know-how and discourages them from co-operation with government bodies.

(iii) Comment on Foreign Government Agencies

We do not favour the establishment in Canada of government-sponsored, industry-wide research associations like BISRA and IRSID. While they are very fine organizations, we consider them appropriate only in countries where industry is nationalized or government regulated. In a free enterprise economy like Canada's, we believe that such organizations would interfere with the spirit of competition and the prerogative of each firm in an industry to reach its own decisions as to whether it wishes to engage in research and the type of programme which it wishes to pursue. We prefer to carry on our own programmes either alone or in voluntary association with other companies or government agencies which have a compatible interest in a particular subject.

(c) Government Information Services

(i) List of Existing Services

One of the greatest problems of the modern scientist is to keep abreast of the vast flow of information which is being produced today. The steel industry has traditionally been very open in the exchange of technological information. However, government can assist in this area by providing centralized clearing houses for scientific information.

In Canada, the following agencies are designed to serve this function:

National Research Council Technical Information Service
National Science Library
Canadian Patent Office.

(ii) Comment on their Services and Recommendations

We have from time to time made use of the National Science Library and have found the service to be first rate. We would recommend, however, that its facilities should be expanded and steps taken to enable the staff to provide an expanded service, especially as regards a "retrospective search", that is, obtaining relevant information on a given subject, as requested.

The Canadian Patent Office is a storehouse of technology which should be readily accessible to industry as is the case with the U.S. Patent Office. While the staff is courteous and co-operative, we find that the lack of facilities and archaic system of patent retrieval of Canadian patent art forces us to use the U.S. patent art.

With respect to the Technical Information Service, we would recommend that its services should be re-organized, possibly along the lines of the Technical Information and Library Services Reports Centre of the Ministry of Technology of the United Kingdom and of the U.S. National Referral Centre for

Science and Technology, Library of Congress. A summary of the former service is attached hereto as Schedule B.

In addition, we recommend that government employees responsible for disseminating technical information should be given opportunities to study segments of Canadian industry so as to become better acquainted with the information needs of industry through a programme organized with the co-operation of industry. This might be accomplished by a system of sabbatical leaves or assignments.

6. Motivation of Research Personnel

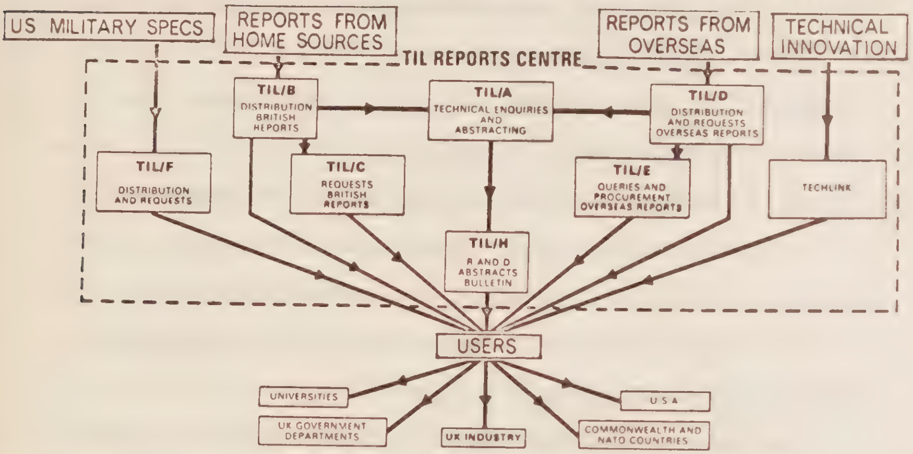
(a) General

In order for a country to have an effective research programme, it is essential to attract, develop and retain highly qualified research personnel. In our view the ability to meet these objectives depends largely on the following factors:

(i) the availability of high-calibre educational facilities in Canada;

(ii) the availability of courses in applied research in the curriculum of our educational institutions and the encouragement of students to enroll in these courses;

Dip into Mintech's TIL—for R & D information



Each year a substantial flow of technical reports pours out from UK government research and development establishments and government sources in Commonwealth and NATO countries. Such reports contain a great deal of information on processes, materials, instruments and systems. For anyone in industry or elsewhere to discover what useful information is available in this mass of material, and to obtain access to it, would be a more than formidable task were it not for the services provided by the Technical Information and Library Services (TIL) Reports Centre of the Ministry of Technology.

The aim of the TIL Reports Centre is to collect all such reports likely to be of interest, and to make them as widely available as possible. This is done through three basic services: regular publication of abstracts and lists of material collected, distribution of a series of leaflets on specific items of technical innovation under the title *Techlink*, and a technical inquiry service which includes the compiling of bibliographies to customer's requirements.

Abstracts are presented as a bulletin, *R & D Abstracts*, published twice a month. They are compiled from the 35,000 new technical reports which the Centre acquires each year. The total stock consists of over half-a-million titles. So massive is the involvement in R & D by the countries represented and so extensive is the subject coverage that almost any interest can be catered for. The subjects include aeronautics; astronomy; atmospheric and earth sciences; behavioural, biological and medical sciences; chemistry; electronics and electrical engineering; energy conversion; materials; mathematics; mechanical, industrial, civil and marine engineering; methods and equipment; military sciences; navigation and communication; nuclear science and technology; ordnance; physics; propulsion and fuels; and space technology. *R & D Abstracts* is obtainable on subscription of £12 per year, which includes free loan of the reports listed. Copies of the reports can be purchased at printing cost. A complimentary copy of *R & D Abstracts* can be obtained from the Centre.

Among the reports from NATO countries are those issued by the US National Aeronautics and Space Administration and certain reports issued by the US Department of Defense. US Military Specifications are also received by the Centre, whose library of these documents currently amounts to 50,000 titles. Apart from their military role, 'Milspecs' are being increasingly used as the basis of commercial specifications, especially by overseas buyers. Of particular interest are the MIL Standards and Handbooks which are comprehensive guides to specialist subjects such as micro-electronics, semiconductor devices, and sampling procedures for inspection and quality control. Lists of newly received US Military Specifications and NASA reports are included as supplements, usually monthly, in *R & D Abstracts*.

Innovation data

The reports announcement service is complemented by the *Techlink* service which provides a rapid and selective communication of information on new ideas, equipment, processes and materials to individuals in industry. A one- or two-page leaflet, each *Techlink* contains the essentials of a particular technical innovation. The material is gathered from the Centre's collection of reports, from the United Kingdom Atomic Energy Authority, the National Research Development Corporation and from the Ministry's own research and development establishments. Each leaflet gives details of where and how further information can be obtained.

At present *Techlinks* are being provided without charge on an experimental basis. They are designed as a personal service to those in industry who are concerned with research, design and development and who can directly exploit the information presented. The subjects covered are classified under 52 headings and customers receive only those *Techlinks* that are relevant to their interests. Included in this service are *Report Announcement Techlinks* which summarise new reports of special technological interest. *Techlinks* or information about the service can be obtained through the Ministry of Technology's Regional Offices (listed on page eight) or a local Industrial Liaison Officer.

With the total literature resources of their library behind them, the scientific and technical staff of the Centre are able to provide an effective technical enquiry answering service. Continuing bibliographies on electronics reliability, micro-electronics, fluidics, lasers and metal joining are compiled and published at intervals. Other bibliographies, based on report literature, can be prepared for a small charge.

More information: TIL Reports Centre (Ref NT), Ministry of Technology, Station Square, St. Mary Cray, Orpington, Kent, BR5 3RE. Telex 896866. Tel: Orpington (01-66) 32111, extns. 19 (Techlink); 20 (R & D Abstracts); 25 (technical enquiries); 45 (foreign reports); 102 (British reports); and 110 (US Military Specifications).

Schedule B

(iii) the orientation of university staff towards encouraging students to seek careers in Canadian industry;

(iv) the availability of adequate research facilities in Canadian industry;

(v) the availability of employment in Canadian industry which is attractive in terms of facilities, duties, after-tax income and opportunity for development and advancement.

(b) Educational Facilities in Canada

With respect to educational facilities, in the last twenty years provincial governments in Canada have devoted vast sums to the improvement of education. Industry has made large contributions for the same purpose. Higher education is available to any able student and facilities for scientific education are generally very good. It must be recognized that, because of the rapid expansion of our universities, there are problems in the area of instruction and that our newer institutions have not yet attained widespread recognition. However, these inevitable problems will be solved with time provided that staff of the necessary calibre can be attracted to and retained by our universities.

(c) Orientation of Academic Staff

The orientation of university staff, however, has not always been conducive to attaining the aims of a desirable science policy. Too often in the past there has been a great

gulf fixed between business and the academic community. Industry has been trying to bridge this gap by programmes such as this Company's scholarship and bursary programme and the endowment of professorial chairs. However, there is still much to be done. It is suggested that government and the universities should take a greater interest in this problem. The universities, for example, should be encouraged (by government assistance, if necessary) to provide opportunities for professors to work in industrial research organizations. The National Research Council in making grants in aid to university professors should give preference to those who have industrial experience or who are interested in pursuing "oriented" fundamental research related to the national science policy. Professors might make an effort to direct the thesis work of graduate students towards studies of greater practical value to industry.

(d) Employment Opportunities in Canada

With respect to availability of industrial facilities and employment opportunities, we feel that government incentive programmes have contributed greatly to the ability of industry to offer attractive opportunities. We believe that our recommendations in this area would enhance the effectiveness of such programmes.

(e) Tax Policy and the Retention of Research Personnel

In spite of all these efforts and the progress which has been made in recent years, we must never forget that we are competing for available personnel with the U.S.A. which can offer longer established and better known universities with more extensive programmes and a greater number of attractive employment opportunities. Probably the most important factor in determining whether this country can maintain an effective research programme which will achieve the aims set out earlier in this brief is the ability of industry to retain highly trained, motivated, able and experienced research personnel. Research personnel are no more impervious than others to the attractions of higher salaries, larger laboratories and greater opportunities for development and advancement than can be provided in a relatively small country. In addition, these people are in short supply and are highly mobile. We are convinced that there is a serious loss of such people to the U.S.A. One of the most effective ways of making Canada attractive to able people would be to make our tax system attractive as compared with the U.S.A. At the present time, we believe the reverse to be true. Our personal income tax, particularly when combined with gift tax and estate tax, is too highly progressive and too heavily weighted against the able, the industrious and the thrifty. Research personnel tend to be in or working

toward the salaried upper middle income brackets on which our tax system rests most heavily. We believe that one of the most important recommendations which we can offer is that the Canadian tax climate should be made sufficiently attractive that highly qualified people will be induced to remain in Canada in spite of the fact that for the foreseeable future employment opportunities will be more attractive in the U.S.A.

May 30, 1969.

APPENDIX 173

<u>BRIEF TO THE</u>

<u>SENATE SPECIAL COMMITTEE ON SCIENCE POLICY</u>

<u>PRESENTED BY</u>

<u>ALUMINUM COMPANY OF CANADA, LTD.</u>

Montreal March 1969

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GENERAL CONSIDERATIONS

Aluminum Company of Canada, Ltd. presents this brief to the Senate Special Committee on Science Policy from the dual standpoint of a corporate citizen and of a business enterprise.

This company, like its parent, Alcan Aluminium Limited - usually referred to as Alcan - is a Canadian enterprise with head office in Montreal which engages in all phases of the aluminum business. While Canada has the third largest per capita aluminum usage in the world, the basic fact remains that Aluminum Company of Canada, Ltd. has to look to export markets to consume some 85 percent of its domestic primary production.

The success of this company depends in large part on its ability to compete internationally as well as on the efficient performance of its personnel and the effective utilization of its assets.

As a corporate citizen, Aluminum Company of Canada, Ltd. believes that the general welfare and further progress of the country - through a sound national policy for research and development - should be built in great part upon the fundamental belief that international trade is a desirable and necessary pursuit for Canada and that this country should use its resources to produce those goods which it can produce most efficiently and - for that portion of these goods exceeding the needs of the domestic market - to exchange them in foreign trade for goods which it is less suited to produce.

As a business enterprise the primary objectives of this company are those of continual growth and increasing profitability by coping with, adapting to, and creating change. To meet these objectives this company relies not only on its extensive applied research and developmental facilities in physical science but also, to a large degree, on the promotion of managerial and inter-personal skills and capabilities, because they have a large influence on creativity, efficiency and productivity. It is felt by this company that these two types of activities cannot be divorced from one another and must instead go hand in hand to achieve optimal results. An overview of Alcan's research activities in these various fields is appended to this submission not because it is comprehensive, but rather because it is indicative of the company's own policy. This summary also is meant to bring to light the rationale behind the accompanying set of suggestions.

The recognition that major change impinges on each country and on each business enterprise with increasing force is continually reshaping the general policies which serve as guidelines for this company, and has had a strong impact on the content of this brief.

The new pervading environment - largely influenced by the computer - has set in motion an irreversible trend toward the "systems" approach for multiplying the effectiveness of human enterprise. It emphasizes such matters as connecting links, accessibility of information, awareness by any organization of the operation of its parts and of its innovating capabilities.

This view replaces static fragmentation by dynamic wholeness. Constant communication and participation thus become essential by-products of constant change. All organizations, to ensure their survival and progress, have to introduce more flexibility and mobility in their behaviour and become more readily responsive. They have to assess more critically and compare more extensively all courses of action and develop a greater awareness of current and emerging challenges, pressures and constraints.

In this context, a Canadian science policy needs to have built-in mechanisms for adjustment and self-renewal to ensure the constant review and improvement of all its facets, in a comprehensive fashion, by intimately involving all the segments of the scientific community - government, universities, industry and independent innovators. In this way this policy would remain adequate and relevant at all times and contribute to the efficient tapping and enhancement of the country's scientific technological resources and to the optimization of the activities deriving from their use.

Such a policy would be apt to accelerate economic growth, increase productivity, encourage employment, upgrade the standard of living, improve education, favour social and cultural development and, generally, make human life more satisfying for Canadians.

SUGGESTIONS FOR A SCIENCE POLICY

As an elaboration on the preceding considerations, it is hereby suggested that the following features be considered for inclusion in a national science policy for Canada.

1. A Coordinating Authority for Canada's Scientific Community

   Establish a coordinating authority for Canada's scientific community. It could absorb some of the ongoing research agencies of government, create new ones, and integrate closely their activities with those of other agencies which for various reasons would continue to operate within the sphere of their current departments. This function could be readily undertaken either by an existing instrument or a new one which might take the form of a Department of Science and Technology, but what is of paramount importance in this age of increasing complexity is to make sure that it be provided with the authority to take all necessary means and steps to maximize the over-all return accruing from governmental agencies.

2. A Permanent Advisory Committee

   Attach to the coordinating center a permanent advisory committee, representing appropriately all segments of the Canadian scientific community. This committee would review the adequacy and pertinancy of the science policy; evolve a set of national goals to be met by the development and stimulation of science and technology and the encouragement of innovation; propose social and economic objectives and priorities, taking into account the resources, capabilities, needs,

characteristics, aspirations and limitations of the country; identify those areas where Canada can compete with advantage; and generally insist on the necessity of assuring greater profitability and more usable results from the government's spending by concentration on research intimately tied to social and economic objectives. This role could possibly be assigned to the Science Council of Canada provided it gave a better representation to all those involved.

3. Liaison Within the Scientific Community

Mostly through the permanent advisory committee, the science and technology center would ensure close and easy liaison between all segments, and the individuals therein, of the scientific community by disseminating information on its activities and through meetings, study sessions, polls and surveys and by facilitating and simplifying direct contacts. A balanced representation of all groups concerned would be maintained on all other advisory and planning committees. .

4. Repository for Available Information

Set up, within the new science center, a national information pool which would collect, file, and disseminate all existing data as well as all data currently being generated by government agencies, university research centers and other non-proprietory sources throughout the country, and all other readily available data from foreign sources.

5. Computerized Retrieval of Information

Ensure fast and reliable retrieval of information from the masses of data stored in the national information pool by using a computerized

system to permit effective and economical response to any valid request originating from the Canadian scientific community or from any other legitimate party.

6. Change of Emphasis in Research

Encourage the reapportionment of research activities in order to lower the national investment in basic or pure research and to correspondingly increase that portion allocated to applied and developmental research to bring the ratio between these two forms of research in line with that of industrial competitor nations who place a greater emphasis on short-term returns and tangible benefits.

7. Redistribution of Basic Research Activities

Review the allocation of government-sponsored basic research to allow a greater share to university centers and a smaller one to the government's laboratories in order to distribute these activities, and the scientists engaged therein, more evenly across the country.

8. Stimulation of National Research Investment

Develop risk-reducing or risk-sharing mechanisms for research and development in potentially beneficial activities. Contribute, through a variety of well-tailored, flexible and appealing means, to the gradual increase of the overall national investment in these activities at least to the level reached in industrial competitor nations. Such activities, when judiciously selected, play an important role in generating new technologies and improving current ones; in bringing about new products, processes and businesses and ameliorating those already in existence; in

solving economic and social problems; in attracting, retaining and developing professional and technical talent; and, more generally, in contributing to the productivity and growth of the country and to its overall well-being.

9. <u>The Initiation of Major Projects</u>

Using a systems approach for selection, planning and implementation, initiate major research projects on problems and tasks exceeding the capabilities of any single party by favouring the joint participation of government, universities and industry. Carry out these projects with the most appropriate organization and in the most efficient manner to minimize the risk inherent in each phase. As was established in the U.S., such large undertakings often do set in motion a chain reaction which spins off scientific, technological, economic and social benefits of considerable and lasting value besides promoting a healthful spirit of collaboration between the participants.

10. <u>Collaboration Between Government and Universities</u>

Maintain federal support at an appropriate level to universities for their participation in basic research.

11. <u>Collaboration Between Universities and Industry</u>

Increase collaboration between the universities and industry by granting, in appropriate cases, a tax write-off for industry-sponsored projects carried out either in academic research centers or in industrial concerns involved.

12. Collaboration Between Government and Industry

For the major projects previously described, and other government initiated projects, award research and development contracts to industry on a competitive basis, except in specific instances where bidding would not be appropriate or practicable.

Support Canadian industry by simplifying, improving and expanding current research and development tax incentive programs such as outlined in Sections 72 and 72-A of the Income Tax Act and consider, in particular, the resumption of the bonus deduction, terminated in 1967, for expenditures over a "base" level. Tax incentives, based on success, are still the best way to stimulate innovation in the private sector of Canadian industry.

Direct federal grants to industry for research and development should be considered in special cases where there is substantial public interest, such as in promoting area development or particular activities.

13. Collaboration Between Government and Small or New Industry

In addition to the above suggestions, the smaller or new enterprise may call for more support, in the form of either generous contracts or of grants and technological help. These additional incentives would have to be weighed against the potential and validity of the claims.

14. Collaboration Between Government and the Independent Innovator

Adequate means have to be devised to encourage inventors and other independent innovators to remain within this country in order for it to benefit from their creativity by providing effective assistance in financing promising inventions through all stages leading to development.

15. Products and Processes

The encouragement of technical innovations should not be limited to products but should also extend to processes. Newness should not be the sole criterion as improvement of existing products and processes is often of prime importance.

16. Behavioural Research and Manpower Development

Innovative and technical proficiency does not by itself ensure success. Extensive studies must also be conducted in management science to increase the conceptual ability of management and to provide them with new tools, especially in regard to decision-making. Similar studies must be undertaken on the social and economic climate for the identification of developing patterns and trends and in behavioural science for the development of more adaptive organizational structures and behaviour, and to increase the personal skills of management and staff for better adjustment to a dynamic environment.

APPENDICES

OVERVIEW OF ALCAN'S RESEARCH EXPERIENCE

As stated previously, this company is continually engaged in a variety of research and development activities. The following description is not intended to cover all phases, rather it provides a short overview supported by a few typical examples of trends and innovations.

The Aluminum Company of Canada, Ltd. is unable to comment on whether foreign ownership is a hindrance to developmental research in Canadian industry. On the other hand, there is no evidence that foreign science and technology are not readily available.

The federal agencies appear to be highly oriented toward pure science. There is little spin-off from NRC research that can be used in the aluminum industry in particular. This may not apply to Canadian industry as a whole, but the question of whether NRC and other government agencies engaged in research relate their programs to the needs of industry in general may well be asked.

Physical Research and Development

Research outlays by this company in 1969 should exceed $15 million. Much of this spending will be concentrated on improvement in process efficiencies and operating techniques, thereby resulting in cost reduction, but attention is focusing increasingly on product-oriented research and related profit opportunities.

In its Kingston, Ontario, laboratory, the company investigates metallurgical problems connected with the fabrication of semi-finished products, and

also studies casting, rolling, extruding, welding, finishing and other processes connected with the fabrication and utilization of aluminum.

In its Arvida, Quebec, laboratory, research and development is concentrated on improving processes in the raw material and smelting fields and on increasing production efficiency. Tolerances on trace impurities, alloy composition limits, metal cleanliness, gas content, grain size and metallurgical structures are being progressively reduced, as new applications are sought and customer requirements become more stringent. To meet these demands successfully, improvements are being sought in methods of handling molten metal during transfer, and in holding, remelting and casting the metal. Concurrently, the quest continues for greater refinement in analytical methods and quality control.

In the Montreal General Engineering Departments and in other research facilities the company is engaged in the design and improvement of various types of plants and processes for production and fabrication. Other developmental work is accomplished in plant laboratories and under actual production conditions. The task force approach is often used on major projects.

There is a continuing study and evaluation of methods for improving hydroelectric power production and transmission. For instance a patent has been granted for a unique self-damping cable for use in overhead transmission lines. Field testing has successfully proven the value of such a system in preventing aeolian vibration and several power utilities are currently making line installations.

The company's fabricating and manufacturing operations maintain developmental activities which give rise to new processes, equipment and products which contribute to increasing sales in existing markets and the penetration of new ones. In this respect, the marketing research function provides much useful data and guidance.

One interesting example is a new continuous electrochemical pre-treatment process for lacquered coiled sheet to be used in can making. The first commercial unit is now in operation, with three others being designed, one of which will run at speeds considerably faster than conventional chemical treatment lines.

Research conducted on lubricating oils has made possible the production of coiled sheet and foil at significantly increased speeds and with greatly improved surface appearance. Another phase of this broad process improvement program was the development of a continuous monitoring system for control of flatness during rolling. All of this work contributes to higher rolling productivity with improved quality.

A rolling mill under construction in Arvida represents in many respects a breakthrough in the production of re-roll sheet stock, for it will be the first installation of its kind in the world using the Hazelett ingot caster in tandem with a rolling mill to produce re-roll stock continuously, using molten aluminum direct from Alcan's Arvida smelter. This undertaking, supported by the Department of Industry and Commerce, will considerably reduce the need for high inventories and its flexibility will make possible deliveries within several days, rather than weeks, in exceptionally urgent cases.

Another prime example of innovation is the method of construction designed to fill the need for single-family housing of good quality at a cost more within the reach of wage earners than that of housing constructed by standard methods. It consists of fully finished, factory-produced houses. This method was initiated early in 1968 at a new plant in Woodstock, Ontario.

Other important developmental work is pursued vigorously in a variety of fields extending from transportation to boating.

The company has cooperative programs underway with various chemical engineering academic groups - especially with the University of Windsor and with McMaster University. It also maintains close association, including summer employment, with professors of the University of New Brunswick, University of British Columbia, Ecole Polytechnique, Laval, etc. These contacts have been very beneficial to the company and it is planned to continue and expand them.

An interesting step in this connection was the inauguration, first in 1955, at the Universities of Toronto and McGill and, later, in 1960 at Ecole Polytechnique and the University of British Columbia, of a program of research fellowships. Enlargement of contacts with the teaching staffs and, with high calibre students who are also prospective employees, has provided a tangible return.

<u>Behavioural Research and Manpower Development</u>

To gear itself to the situation caused by strong environmental pressures, the company attempts to keep its finger on the pulse of society through its Public Relations Research Department. It thereby develops an awareness at

all times of how the social situation of the organization is evolving with respect to its environment and deduces, from its studies, specific viewpoints and suggestions for keeping the company attuned to the times. Through such means as attitude surveys, this department measures the familiarity of the population with the firm, and its favourability, and also establishes its profile in regard to employer role, ethical reputation, product reputation, customer relations, plant community relations, civic responsibility and corporate vitality.

As the company's organizational structure and leadership patterns must remain adjusted to the rapid change in technologies and markets, the Staff Training and Research Division of the Personnel Department has developed, since 1961, a laboratory approach to organization development which has involved more than 1,000 supervisory personnel at levels ranging from foreman to president.

Throughout the years inter-personal competence has remained one of the primary goals of this program. It also encompasses an overriding concern with the inter-group relations problems, especially those arising from competitiveness and deals with intra-personal insight and inter-personal skill. This is particularly important because there are always many task forces at work, comprised of people with different departmental and functional identification, and representing different levels of authority. It has been found that such temporary groups benefit greatly from human laboratory experience.

Decisions have to be less routine and more innovative in a more complex environment, and this approach favours newer, more adaptive methods of

making them. The organization is thus becoming better suited to constantly changing markets and industrial conditions.

Managers require not only inter-personal skill and sensitivity to human and social variables in the industrial complex, but also further theoretical knowledge and intellectual sophistication. Consequently, programs have been set up to deepen their concepts of the managerial role and assist them in acquiring greater understanding of the implications of changing technology and external environment.

Management development is a joint responsibility of the individual employee and of his superiors who play the key role in his day-to-day development. Central coordination is provided by the Staff Personnel Division. Various resource groups in the training and personnel areas offer essential services. For example, at installations distant from large centres, the company has helped technical employees to update their skills by employing university professors during the summer to give courses and conduct seminars and by using the VERB system to conduct long-range lectures during the winter months. Works staff enjoy fruitful interchanges with universities through co-op and technical exchange programs as well as contacts with individual professors.

Development through experience on the job is insured by a carefully coordinated program of job rotation and advancement, which seeks to provide the appropriate learning experience at crucial points in each employee's career.

In 1967 a variety of programs of educational assistance in force at the various installations were augmented by an integrated continuing education policy, in order to increase the effectiveness of the Company's program in this area. It is available to most staff employees, and is implemented at each location by means of a specific program adapted to local conditions.

The distinguishing features of this policy are emphasis on flexibility and adaptability, and reliance upon the judgement of employees and management. A request for assistance may be initiated by either an employee or the company. Any form of education - related to the needs of the company - may be considered, and no limit is set on the amount of assistance granted. An advisory committee has been set up to foster the development of the program and to keep it abreast of change in the relevance of education to the needs of industry. In other words, continuing education is thereby recognized as an integral part of the work situation. The emphasis is not on whether assistance should be given but rather on what kind of course is appropriate. The official statement on "Company Assistance for Administrative, Professional and Technical Employees for Continuing Education" is attached.

This policy also encompasses a centrally coordinated procedure which, since 1946, has provided for the annual selection of several employees to attend the one-year course of the company's Management Development Program in Geneva.

Health-Oriented Research and Development

Some of the programs undertaken by the Health Services of the Aluminum Company of Canada, Ltd. are mentioned briefly below.

The company has undertaken much research in ergonomics - that is, in human factors involving sensorimotor energy expenditure in productive work. This includes physiological studies conducted since 1944; equipment design related to human constraints, and the need to mechanize highly stressful elements of jobs; job design in conjunction with human factor considerations; and selective placement of personnel by matching physical demands of jobs with physical capabilities of individuals.

Toxicological research - into the effect of exposure to certain chemicals on human beings, animals and vegetation - and epidemiological research are pursued on a regular basis with the close participation of universities. New knowledge and original analytical techniques have evolved from this program. For the same purpose, Alcan owns and operates its own farm in the Saguenay District. The latter also serves to provide instruction in farm management to the local rural population.

Accident prevention research has brought into existence improved standards of illumination, noise levels, eye protection, safety clothing, etc.

Through continuous cooperation and collaboration with university researchers working in our installations, deleterious effects from the rapidly increasing pace of technological change on employees are being reduced.

Finally, several company health centres - besides undertaking periodic voluntary examinations of employees - conduct statistical studies based on their records, disseminate health education information and initiate industrial hygiene programs.

Management Science Research and Development

The growing complexity of business has prompted the company to have its Systems Development Department review its information requirements in many areas, with the purpose of improving decision making.

An excellent example is the new computerized metal records system implemented in December 1967, which daily relates sales commitments to smelter inventories. It facilitates customer service, inventory management and production planning and scheduling. Tied in closely with it is an allocation and bookings control system which provides guidelines and additional data.

A goal which is being given much close attention is the development of an in-line system for tactical or short-range planning, as well as another for medium-range planning.

When analytical tools fail, the methods of model-building and simulation can still be used successfully. While requiring a large amount of computer programming, simulations are not necessarily mathematical in nature, but are logical and can therefore be applied to complex industrial problems, where good compromises replace best solutions. For instance, this approach has been used to design a system for preparing a weekly production schedule for the company's casting alloys production facilities. It is also paying off in analytical study to rationalize and improve the selection of products as part of a pre-production policy.

Another system has been designed to calculate sags and tensions in transmission lines subjected to a variety of loading conditions. It is used

both for supplying tabulations on cable conditions and for the company's research purposes. A variation of this program presents the results in a graphical format.

A computer program has been written to simulate the hot metal production facilities existing in the company's smelters. It calculates the contribution from various outputs to determine which production level best satisfies the full range of the sales forecast.

The critical path and Pert techniques have contributed to the improvement of the control of several construction projects. Other studies involve structural engineering, electrical design, utilization of port facilities and other phases. Much progress has also been achieved in computer control of operations, particularly in smelters.

1st September 1967

ALUMINUM COMPANY OF CANADA

COMPANY ASSISTANCE TO ADMINISTRATIVE, PROFESSIONAL AND TECHNICAL EMPLOYEES FOR CONTINUING EDUCATION

Foreword

The Company, recognizing that its success depends on the abilities of its employees, has normally encouraged self-development by giving added or broader responsibilities to those who have increased their skills and knowledge. It has helped many to improve their qualifications and capabilities through continuing education and, to keep pace with the growth of knowledge, and technological, economic and social change, has decided to make more aid available and to broaden its scope. To this end, a more comprehensive programme of assistance for continuing education has been established.

The application of new knowledge is of mutual benefit to the individual employee and to the Company, and they have mutual responsibility for its acquisition. Every person in a supervisory position is called upon to identify education which would benefit the Company and to recommend it for qualified employees in his area of responsibility. The individual employee has a corresponding opportunity to propose appropriate education for himself.

The continuing education programme will assist employees to attend suitable formal courses, but the Company recognizes, and employees will recognize, that coaching and instruction received during the course of normal employment and experience gained through daily work are also a form of education and as such, augment the employee's personal, professional, and occupational qualifications.

I. Objectives of the Programme

This programme will help to assure the continued availability within the Company of the skilled and qualified employees necessary to its success:

1. By encouraging self-improvement and providing comparable educational opportunities at all Company locations.

2. By aiding administrative, professional, and technical employees who wish to supplement their employment experience and/or improve their academic qualifications by means of suitable courses of continuing education.

1 September 1967

II. Definitions

For the purpose of this statement, the following definitions shall apply:

1. "Continuing education" means education of an employee during his period of employment by the Company.

2. "Assistance" means financial aid given by the Company to employees continuing their education.

3. "Administrative, professional, and technical employees" are defined below:

(These classifications are neither mutually exclusive nor all-embracing).

(a) "Administrative Employees" are employees occupying administrative posts.

(b) "Professional Employees" are employees who possess university degrees or their equivalent.

(c) "Technical Employees" are other employees whose work requires a high degree of specialized knowledge in such fields as the physical sciences, finance, and personnel administration.

III. Terms of Assistance

1. The extent and type of assistance will be determined by the employee's present qualifications, the nature of the proposed course of studies, and the needs of the Company and the employee at the time at which the application is made.

2. Once approved by the Company, Assistance will vary from 50% to 100% of tuition costs, according to the circumstances of each case.

3. Where appropriate, a supplementary allowance will be provided to cover expenses related to either Company-initiated or employee-initiated courses.

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4. Assistance will be provided on evidence of registration in the course of study.

IV. Responsibilities of the Assisted Employee

The Company will rely on the good judgement and sense of responsibility of its employees, rather than formal obligations, to ensure that its expenditures on Continuing Education will benefit both the Company and the assisted employee. The employee may, however, be asked to give his opinion of a course for which he has been assisted. This measure is intended to provide information on courses, not on the achievements of the employees.

V. The Advisory Committee on Continuing Education

1. The Committee will be appointed by the Vice-President - Personnel.

2. The Committee will be composed of about five senior employees, representing insofar as possible a cross-section of disciplines and business functions.

3. A permanent secretary will be provided by the Personnel Department.

4. In order to assist Management in using this programme to compensate for differences in educational opportunity between locations, the Committee will assemble and make available information on continuing education programmes both within and outside the Company.

   (a) The Committee will record precedents for the granting of assistance and, drawing upon the opinions of participants, their superiors, and Company specialists, will evaluate courses. It will also maintain a listing of employees qualified to act as instructors for internal courses.

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(b) The Committee will advise Management on the implementation and development of the programme. It will recommend guidelines for setting rates of assistance and evaluating individual programmes and will keep Management informed of the costs of the Continuing Education Programme. It will give the Works Manager or Montreal Department Head information enabling him to compare his programme with the general practice in the Company and will supply him with other data or advice at his request.

5. The Committee will prepare information on the Company's Continuing Education Programme for potential applicants and their superiors and may interview some applicants.

VI. Implementation Procedures

1. Assistance may be initiated by the candidate himself, by Works or Montreal Departments.

2. The following procedure will be used:

(a) Application forms for assistance will be made available.

(b) The applicant who acts on his own initiative will apply through his immediate superior.

(c) The Works Manager or Department Head will consider the merits of the case and (except as provided for in Section VI-4 below) will decide what assistance will be offered.

(d) The particulars of all requests decided at the local level will be made known to the Advisory Committee. Where appropriate, (see for example, Section VI-4. (c) and (d)), the Committee may undertake to find an alternative source of assistance.

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(e) If the applicant is not granted the assistance requested, the reason for the decision will be discussed with him. He may submit an alternative request, or, after a suitable interval, repeat the original.

(f) Applications which are subject to central decision, (See Section VI-4 below), and others which the Works Manager or Montreal Department Head chooses to refer, will be forwarded with his recommendations to the Head of his Division and a copy will be sent to the Committee. After reviewing the request and, possibly, interviewing applicants, the Committee will offer its comments to the Head of the Division, or other appropriate authority, who will make the final decision.

3. Requests initiated by Management will be subject to the same procedure as requests initiated by applicants (i.e. certain categories of assistance will be awarded by central decision, and all awards made will be reported to the Advisory Committee for recording).

4. In the following cases, the final decision on assistance will be made centrally.

(a) All cases where the period of paid absence or the total expenditure for a single employee (tuition plus related expenses, exclusive of salary) exceeds that which a Works Manager or Department Head is permitted to authorize for other purposes.

(b) All cases involving a course of study for which Management decides to limit total Company expenditure or for which the number of Company employees who can attend is limited by the decision of Management or by other considerations.

(c) All cases where the Works or Montreal Department thinks that the Company may benefit by the expenditure but is unwilling to accept responsibility for the cost.

1st September 1967

(d) All cases where the Works or Montreal Department prefers to delegate the final decision.

VII. Budgeting of Expense

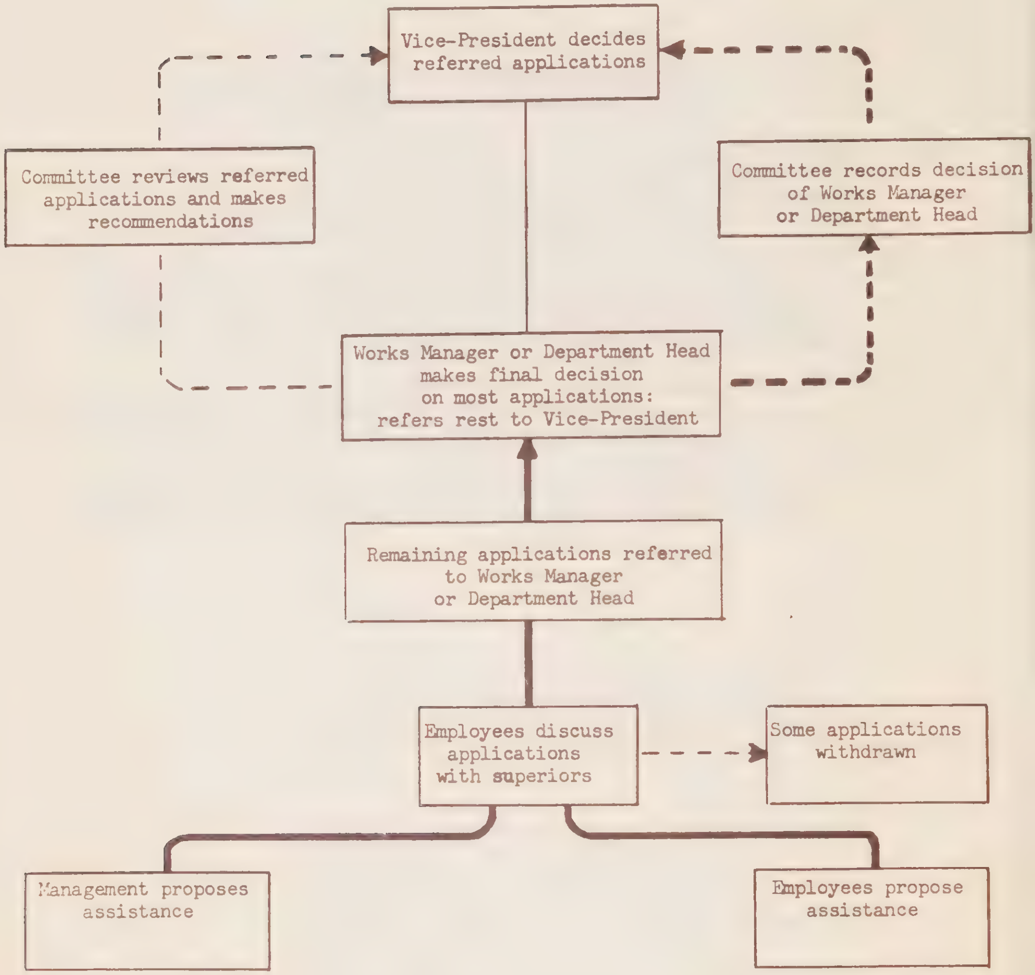
1. Each Works and Montreal Department will include in its annual budget an item for assistance to continuing education.

2. An additional fund will be budgeted centrally to provide some support for employees who are not assisted by Works or Montreal Departments. The office and administrative expenses of the Advisory Committee will also be covered by this fund.

3. Expenses under this programme will be covered by an annual Request for Appropriation prepared by the Advisory Committee on the basis of Works' and Montreal Departments' needs.

4. The Chief Accountant will provide Works and Montreal Departments with instructions on the recording of expenditures on education.

FLOW CHART FOR ASSISTANCE TO CONTINUING EDUCATION



First Session—Twenty-eighth Parliament

1968-69

THE SENATE OF CANADA

PROCEEDINGS

OF THE

SPECIAL COMMITTEE

ON

SCIENCE POLICY

The Honourable MAURICE LAMONTAGNE, P.C., *Chairman*
The Honourable DONALD CAMERON, *Vice-Chairman*

No. 72

TUESDAY, JUNE 24th, 1969

WITNESSES:

The Bobtex Corporation Limited: Dr. Emilian Bobkowicz, President, Dr. A. J. Bobkowicz, Vice-President, Research and Development; Air Industries Association of Canada: Dr. D. A. Golden, President, Mr. S. Roth, Chairman, Research and Development; United Aircraft of Canada Limited: Mr. R. D. Richmond, Vice President (Operations) and Member of the Board of Directors, Mr. Elvie L. Smith, Vice-President (Engineering); Aviation Electric Limited: Mr. D. R. Taylor, President; Canadair Limited: Mr. R. J. Ross, Chief Development Engineer.

APPENDICES:

174—Brief submitted by The Bobtex Corporation Ltd.
175—Brief submitted by Air Industries Association of Canada
176—Brief submitted by United Aircraft of Canada Limited

20668—1

MEMBERS OF THE SPECIAL COMMITTEE
ON
SCIENCE POLICY

The Honourable Maurice Lamontagne, *Chairman*
The Honourable Donald Cameron, *Vice-Chairman*

The Honourable Senators:

Aird
Bélisle
Blois
Bourget
Cameron
Carter
Desruisseaux
Giguère
Grosart
Haig
Hays
Kinnear
Lamontagne
Lang
Leonard
McGrand
Nichol
O'Leary (*Carleton*)
Phillips (*Prince*)
Robichaud
Sullivan
Thompson
Yuzyk

Patrick J. Savoie,
Clerk of the Committee.

ORDERS OF REFERENCE

Extract from the Minutes of the Proceedings of the Senate, Tuesday, September 17th, 1968:

"The Honourable Senator Lamontagne, P.C., moved, seconded by the Honourable Senator Benidickson, P.C.:

That a Special Committee of the Senate be appointed to consider and report on the science policy of the Federal Government with the object of appraising its priorities, its budget and its efficiency in the light of the experience of other industrialized countries and of the requirements of the new scientific age and, without restricting the generality of the foregoing, to inquire into and report upon the following:

(*a*) recent trends in research and development expenditures in Canada as compared with those in other industrialized countries;

(*b*) research and development activities carried out by the Federal Government in the fields of physical, life and human sciences;

(*c*) federal assistance to research and development activities carried out by individuals, universities, industry and other groups in the three scientific fields mentioned above; and

(*d*) the broad principles, the long-term financial requirements and the structural organization of a dynamic and efficient science policy for Canada.

That the Committee have power to engage the services of such counsel, staff and technical advisers as may be necessary for the purpose of the inquiry;

That the Committee have power to send for persons, papers and records, to examine witnesses, to report from time to time, to print such papers and evidence from day to day as may be ordered by the Committee, to sit during sittings and adjournments of the Senate, and to adjourn from place to place;

That the papers and evidence received and taken on the subject in the preceding session be referred to the Committee; and

That the Committee be composed of the Honourable Senators Aird, Argue, Bélisle, Bourget, Cameron, Desruisseaux, Grosart, Hays, Kinnear, Lamontagne, Lang, Leonard, MacKenzie, O'Leary (*Carleton*), Phillips (*Prince*), Sullivan, Thompson and Yuzyk.

After debate, and—
The question being put on the motion, it was—
Resolved in the affirmative."

Extract from the Minutes of the Proceedings of the Senate, Thursday, September 19th, 1968:

"With leave of the Senate,

The Honourable Senator Lamontagne, P.C., moved, seconded by the Honourable Senator Benidickson, P.C.:

20668—1½

That the name of the Honourable Senator Robichaud be substituted for that of the Honourable Senator Argue on the list of Senators serving on the Special Committee on Science Policy.

The question being put on the motion, it was—
Resolved in the affirmative."

Extract from the Minutes of the Proceedings of the Senate, Wednesday, February 5th, 1969:

"With leave of the Senate,

The Honourable Senator McDonald moved, seconded by the Honourable Senator Macdonald (*Cape Breton*):

That the names of the Honourable Senators Blois, Carter, Giguère, Haig, McGrand and Nichol be added to the list of Senators serving on the Special Committee on Science Policy.

The question being put on the motion, it was—
Resolved in the affirmative."

ROBERT FORTIER,
Clerk of the Senate.

MINUTES OF PROCEEDINGS

TUESDAY, June 24, 1969.

Pursuant to adjournment and notice the Special Committee on Science Policy met this day at 3.00 p.m.

Present: The Honourable Senators Lamontagne (*Chairman*), Blois, Bourget, Grosart, Haig, Kinnear, McGrand, Phillips (*Prince*), Robichaud and Yuzyk—10.

In attendance: Philip J. Pocock, Director of Research (*Physical Science*).

The following witnesses were heard:

THE BOBTEX CORPORATION LIMITED
Dr. Emilian Bobkowicz, President
Dr. A. J. Bobkowicz, Vice-President
Research and Development

AIR INDUSTRIES ASSOCIATION OF CANADA
Dr. D. A. Golden, President
Mr. S. Roth, Chairman, Research and Development

UNITED AIRCRAFT OF CANADA LIMITED
Mr. R. D. Richmond, Vice-President (Operations)
and Member of the Board of Directors
Mr. Elvie L. Smith, Vice-President (Engineering)

AVIATION ELECTRIC LIMITED
Mr. D. R. Taylor, President

CANADAIR LIMITED
Mr. R. J. Ross, Chief Development Engineer

(*A curriculum vitae of each witness follows these Minutes*)

The following are printed as Appendices:
No. 174—Brief submitted by The Bobtex Corporation Ltd.
No. 175—Brief submitted by Air Industries Association of Canada
No. 176—Brief submitted by United Aircraft of Canada Limited.

At 5.10 p.m. the Committee adjourned to the call of the Chairman.

ATTEST:

Patrick J. Savoie,
Clerk of the Committee.

CURRICULUM VITAE

Bobkowicz, Dr. Andrew J.: Born in 1936 in Lódz, Poland: Description: Canadian, Married, 5' 11", 180 lbs., 4 children. Languages Polish, French and English. Academic Background: Completed Public School in Poland. Completed one year out of a two year course leading to a degree in Commerce and Economics, in a commercial pre-university Licee (equivalent to the Canadian CEGEP) 1948. Left Poland and completed 1948-49 academic session in Ecole Primaire, Boulogne-Billancourt (Seine), in Paris, acquired a working knowledge of French and English languages. 1953—graduated from Westmount Senior High School, Montreal (cum laude). 1958—Bachelor of Engineering (Chemical), McGill University. 1963—Doctor of Philosophy (Chemical Engineering), McGill University under the auspices of the Pulp and Paper Research Institute of Canada. Title of Doctoral Dissertation: "The Effects of Turbulence on the Flow Characteristics of Model Fibre Suspensions" under the direction of Dr. W. H. Gauvin. Supplementary Education: High Polymers (special course) McGill University 1957. International Trade Course, Sir George Williams University and The Montreal Board of Trade 1960 (placed first). Structure and Mechanical Properties of Fibers and Crystalline Polymers, MIT, 1964. Structural Mechanics of Textile Materials, MIT, 1964. Dynamics of Textile Processes, MIT, 1964. Extrusion principles and practices, International Plastics Industry Consultants Inc., New York City 1967. PACER workship, Dartmouth College, Thayer School of Engineering, Hanover, New Hampshire 1967. Prizes, Honors, Scholarships and Awards: 1953—Westmount Senior High School citation for obtaining the highest scholastic standing in chemistry. 1953—Westmount Senior High School citation for obtaining the highest scholastic standing in physics. 1958—Chemical Institute of Canada, First Prize, student technical paper contest (paper entitled "Thermal Diffusion"). 1958-59—McGill University and National Research Council Summer Grants. 1959-60, 1960-61, 1961-62—McGill University, recipient of the D.S. and R.H. Gottesman Foundation Scholarship. 1960—Sir George Williams University and The Montreal Board of Trade citation for first standing in the International Trade Course. 1960-61, 1961-62—McGill University, Pulp and Paper Research Institute of Canada Summer Scholarships. Industrial Consultant and Lecturer on Digital Computer Applications: Special Lecturer in the Chemical Engineering Department, McGill University since 1963, "Digital Computers in Process Calculations". Special Consultant to the Noranda Research Centre on application of computers between 1963 and 1965.

PAPERS, PUBLICATIONS AND PATENTS

1. "THERMAL DIFFUSION, C.I.C. Student Paper Contest, Montreal, February 1958.
2. "THE TURBULENT FLOW OF MODEL FIBRE SUSPENSIONS", Joint A.I.Ch.E.-C.I.C. Chemical Engineering Conference, Cleveland, Ohio, May 1961. (Co-authored with Dr. W. H. Gauvin).
3. "THE NEW TREND IN FIBRE PROCESSING TECHNOLOGY", Twenty-First Annual Meeting of the Soil and Crop Science Society of Florida Proceedings, *21,* 148-170 (1961).

4. "NEW TRENDS IN FIBRE PROCESSING TECHNOLOGY", The Cotton Trade Journal, 30th International Edition, 26 (1962-63).
5. "THE TURBULENT FLOW CHARACTERISTICS OF MODEL FIBRE SUSPENSIONS", Paper presented at the 13th Annual Chemical Engineering Conference of the Chemical Institute of Canada, Montreal, Canada, October 1963. Bobkowicz, A. J. and Gauvin, W. H., Canadian Journal of Chemical Engineering *43*, 87-91 (April 1965).
6. "THE EFFECTS OF TURBULENCE ON THE FLOW CHARACTERISTICS OF MODEL FIBRE SUSPENSIONS", Paper presented at the 56th. Annual Meeting of the American Institute of Chemical Engineers, Houston, Texas, December 1963. Bobkowicz, A. J. and W. H. Gauvin, Chemical Engineering Science, *22*, 229-241 (1967).
7. "TEXTURED FILAMENT YARN" Patent filed in 22 countries (1963). (Co-authored with and assigned to Mr. Emilian Bobkowicz).
8. "PARALLELIZATION OF STAPLE FIBERS BY ELECTROSTATIC MEANS", patent in Canada and the U.S.A. (1965). (Co-authored with Mr. Emilian Bobkowicz).
9. "UNIVERVAL OPEN-END SPINNING METHOD OF MULTICOMPONENT YARNS PRODUCTION", patent filed in 29 countries (1967). (Co-authored with Mr. Emilian Bobkowicz).
10. "MANUFACTURE OF FIBERTAPES", patent filed in 29 countries (1967) (Co-authored with Mr. Emilian Bobkowicz).
11. "METHOD AND APPARATUS FOR RINGLESS SPINNING OF FIBER-POLYMER YARNS" patent filed in Canada and U.S.A. (1968). (Co-authored with Mr. Emilian Bobkowicz).

PROFESSIONAL SOCIETIES: Member: American Institute of Chemical Engineers, The Corporation of Professional Engineers of Quebec, The Engineering Institute of Canada, Canadian Society for Chemical Engineering, Association of Polish Engineers in Canada, Computer Society of Canada, Association for Computing Machinery, The Soil and Crop Science Society of Florida, Montreal Board of Trade, the post-graduate honourary Society of the Sigma Xi, The Fiber Society, Province of Quebec Chamber of Commerce, The Institute of Textile Science, Society of Plastics Engineers Inc. PREVIOUS EMPLOYMENT: Summer Employment: Belle Glade Experimental Station, Florida, U.S. Department of Agriculture (Ramie fiber decorticating) 1955; North American Cyanamid Limited, Niagara Falls, Ontario, (development—calcium carbide and cyanamide production) 1956; DuPont Company of Canada Ltd., Kingston (development—nylon textile fibre production) 1957; McGill University, Part-time demonstrator, 1958-59, 1960, 1961. TEXTILE BACKGROUND: Since his birth, Dr. Bobkowicz was practically constantly exposed to textile oriented matters. The city of his birth, Lódz, is the largest textile centre in Poland and is otherwise known as the "city of a thousand chimneys", the latter all stemming from textile mills. At home he was constantly aware of his father's textile materials and machines transactions and more recently of the textile inventions and new ideas. These were always discussed frequently and openly and with a great deal of father-son-participation. Dr. Bobkowicz's interest is therefore deeply rooted. Two of his Summer Technical Papers for McGill were on textile subjects, the first on "Ramie Fibers" and the second on "Nylon Yarn Production". His knowledge of Ramie cultivation, decortication and utilization stemmed from experience gained by spending part of the summer of 1955 at the Everglades Experiment Station

in Bell Glade, Florida, where the U.S. Government is conducting research on Ramie cultivation under the direction of Dr. R. V. Allison. His know-how on nylon textile yarn production was gained while employed at the DuPont of Canada nylon plant in Kingston. The textile inventions of his father, Mr. Emilian Bobkowicz, further heightened his interest and encouraged him to absorb books and technical literature on all aspects of the textile industry on a continuous basis, which he has now been doing for a number of years. With the advent of the man-made fiber industry, dominated by the chemical corporations, and the revolutionary ideas encompassed in his father's inventions, Dr. Bobkowicz's Chemical Engineering training really became the necessary qualifications of the new generation of textile experts. The marriage of chemistry and conventional textile processing resulted in the chemical engineer being the new style textile engineer, particularly if one also considers the role played in these developments by the paper manufacturing process, traditionally the domain of the chemical engineer. In this respect, Dr. Bobkowicz's link with the Pulp and Paper Research Institute of Canada and the choice of thesis work performed for his doctorate was particularly fortunate and generated an exceedingly suitable background for his further work in the development and implementation of his father's textile inventions, in some of which Dr. Bobkowicz is a co-inventor himself. The more detailed interrelations involved are further discussed in Dr. Bobkowicz's paper on "The New Trend in Fiber Processing Technology". Current Position: Since 1963, Research Director and Vice President in charge of R.&D. of Emilian Bobkowicz Limited. Since 1967, Research Director, Vice President in charge of R.&D. Treasurer and Director of The Bobtex Corporation Limited.

Bobkowicz, Emilian: Born 1903 in Poland: immigrated into Canada 1949; obtained Canadian Citizenship 1955. Married with two children. Education: Master degree, Political/Economical Science, Warsaw Academy of Political and Economical Science. Languages: English, Polish, Russian, German.

Golden, David A. Mr. Golden was born in Sinclair, Manitoba on February 22, 1920. He graduated from the University of Manitoba Law School with the degree of LL.B., in 1941, and received the Honourable Alexander Morris Exhibition for highest standing in all four years of the University law course. He was appointed Rhodes Scholar in 1940. Mr. Golden enlisted in May, 1941 in the 1st Battalion, The Winnipeg Grenadiers, and served in Canada, Jamaica and Hong Kong. He was a prisoner of war in Hong Kong from December 1941 until September 1945 and was discharged from the army in December, 1945, with the rank of captain and adjutant. In January, 1946 he started the practice of law in Winnipeg with Mr. Samuel (now The Honourable Mr. Justice) Freedman, under the firm name of Freedman and Golden. He attended The Queen's College, Oxford, from October, 1946 until June, 1947. On his return to Winnipeg he resumed the practice of law and also lectured at the Manitoba Law School. In May, 1951 Mr. Golden joined the Department of Defence Production as Director of the Legal Branch and a year later assumed the additional post of Associate General Counsel. In February, 1953 Mr. Golden was made Assistant Deputy Minister and General Counsel of that department. Mr. Golden was appointed Deputy Minister of Defence Production on September 30, 1954, and became President of the Northern

Ontario Pipeline Crown Corporation in June, 1956. Appointment to his present position, President of Air Industries Association of Canada came on July 1, 1962. Mr. Golden also serves as a Governor of Carleton University, Vice-President of National Capital Arts Alliance, Vice-President of Ottawa Canadian Club, and a Director of Atomic Energy of Canada Limited. He is married to the former Molly Berger of Estevan, Saskatchewan, and has three children; two sons and one daughter.

Richmond, R. D.: Position: Vice President (Operations) and Member of the Board of Directors. Company: United Aircraft of Canada Limited, Longueuil, Quebec. Born: Winnipeg, Manitoba—1919. Education: University of Michigan BSE 1942 (Aeronautical Engineering). Career: National Research Council—Ottawa, Ontario 1942—Junior Aeronautical Engineer; Fairchild Aircraft Limited—Longueuil, Quebec 1942—Chief of Aerodynamics and Flight Test; Canadian Car and Foundry Ltd. (Aircraft Division) Montreal, Quebec; 1947—Senior Development Engineer; Canadair Ltd.—Montreal, Quebec; 1949—Chief of Aerodynamics; 1959—Vice President, Missiles and Systems Division; United Aircraft of Canada Limited—Longueuil, Quebec; 1960—Vice President (Operations). Associations: Fellow, Canadian Aeronautics and Space Institute; Associate Fellow, American Institute of Aeronautics and Astronautics; Member, The Engineering Institute of Canada; Member, Corporation of Professional Engineers of Quebec.

Ross, Robert James, D.C.Ae, M.I.Mech.E, A.F. C.A.S.I., C.Eng, P. Eng. Robert James Ross, Chief Development Engineer at Canadair, is a Canadian citizen, born at Farnham, England. He attended the Royal Aircraft Establishment Technical College, Farnborough, England, from 1941 to 1946, where he received Higher National Certificates in Mechanical & Aeronautical Engineering and the R.A.E. Diploma in Engineering. He then completed two years post graduate study at the College of Aeronautics, Cranfield, England, receiving his D.C.ae, in 1948. He began his career as a scientific officer with the Ministry of Supply in the Aerodynamics Flight Section at the Royal Aircraft Establishment Farnborough, engaged on aerodynamics research in flight. In 1952, he joined Canadair as an Aerodynamics Engineer. In the ensuing years, he has held various posts in the Engineering Division of Canadair, including those of Chief Dynamics & Flight Test Engineer and Director, Research & Development. He received his present appointment in May 1969. He was a member of the NRC Associate Committee on Aerodynamics for 3 years, and is currently a member of the Research & Development Committee of the Aircraft Industries Association.

Roth, Sam: Vice-President, Program Development CAE INDUSTRIES LTD. Sam Roth, 44, was born and educated in Montreal, where he received his B.Eng. Electrical degree from McGill University in 1948. He joined Canadair Ltd. in 1948 and was Section Chief, Electronics Research and Development, Aircraft Division when he left to join the Electronics Division of CAE Industries Ltd. in 1960 as Manager, Research and Development Department, Engineering Division. He was named Manager, Research and Development Programs in 1963, and was appointed to his present position as Vice-President, Program Development in 1967. Mr. Roth is a member of the Corporation of Professional Engineers of Quebec, and the Institute of Electrical and Electronic Engineers. Mr. Roth was on the Executive of the Air Industries Association's Research & Development Committee from 1966 to 1968 and is currently Chairman of Research & Development.

Smith, Elvie L.: Vice-President—Engineering, United Aircraft of Canada Limited. Mr. Smith joined United Aircraft of Canada Limited in 1957 as a Senior Analytical Engineer in charge of the performance section. He was appointed to increasingly responsible positions of Chief Project Engineer, Development Engineer and Engineering Manager to his present position of Vice-President—Engineering. Prior to joining this Company and following a short period of lecturing at Perdue University, Mr. Smith joined the Engine Laboratory, National Research Council, Ottawa, where he was active in Research on gas turbine anti-icing and thrust augmentation systems until 1954. For the period following and until joining the Company he worked with the Flight Research Section of the National Aeronautical Establishment on turbojet afterburners. Mr. Smith was graduated from the University of Saskatchewan with the degree of B.Eng. (Great Distinction) in Mechanical Engineering and obtained a Masters degree from Perdue University in 1949. He is the author of a number of research papers concerning gas turbine and anti-icing and turbojet thrust boosting by afterburning. He is an Associate Fellow of the Royal Aeronautical Society and a Fellow of the Canadian Aeronautics & Space Institute. His hobbies are skiing and gliding, and he is holder of Canadian Gold C No. 4.

Taylor, Dudley Robert, P.Eng.: Profession: Engineer (Electrical). Firm Name & Address: Aviation Electric Limited, 200 Laurentien Blvd., Montreal 379, Quebec. Firm's Business: Sale, manufacture and overhaul of aircraft instrument and accessory systems, supervisory control systems, fluidics, navigation systems. Birthplace: Montreal, Quebec. Date of Birth: September 21st, 1914. Education: West Hill High School, Montreal, McGill University, B.Eng. 1937. Career: Electrical Engineer, Air Canada, 1938-43; Tech. Asst. to Chief Engineer, Air Canada, 1944-51; Sales Manager, Aviation Electric, 1952-58; Vice-President, Aviation Electric, 1959-65; Executive Vice-President, Aviation Electric, 1966-67; President, Aviation Electric, 1968-.

THE SENATE

SPECIAL COMMITTEE ON SCIENCE POLICY

EVIDENCE

Ottawa, Tuesday, June 24, 1969.

The Special Committee on Science Policy met this day at 3 p.m.

Senator Maurice Lamontagne (*Chairman*) in the Chair.

The Chairman: Honourable senators, I understand that we have representatives of United Aircraft of Canada Limited, who are unable to attend the meeting this afternoon, probably because of the weather. This is a good industry or company to be the victim of weather. Thus, we only have two groups before us this afternoon.

I should first like to introduce Mr. Emilian Bobkowicz, President of The Bobtex Corporation Limited. He is accompanied by his son, Dr. A. J. Bobkowicz, Vice President of Research and Development, and Mr. Michael Boyd, who is a director of the company. I will ask Mr. Bobkowicz to make his opening statements now.

Mr. Emilian Bobkowicz (President, The Bobtex Corporation Limited): Mr. Chairman and honourable senators, we are honoured by the opportunity given to us to present a case in point of view of a group of Canadian inventors whose experiences during the last two decades, against the background of about 250 patents granted and pending on a worldwide basis in a major secondary industrial field, might well provide useful data and guidelines for shaping Canada's science policy of the future on a more pragmatic mission-oriented basis to make our R & D efforts and assistance programs more responsive to economical results thus to the needs of the market place, which is now the whole world, replacing to an ever greater degree national markets primarily due to the forces of the technological explosion the world is witnessing which defies any political and economical boundaries. No country or company, even the most powerful ones, can hope to become technologically self-sufficient in this age of rapid changes and no amount of money spent on research and development can achieve this goal either.

A major driving force behind this technological revolution is the creative minds of the inventors to which no country or company holds a monopoly. A study made in 1967 by 16 of the United States' leading research administrators for President Johnson on technological innovation came to the conclusion that major inventions, with some important exceptions, were made by little fellows of small companies or the lone "garage inventors type". They have apparently been more inventive than large companies or Government operated R & D institutions. The direct involvement of this inventive force with the future science policy planning should become a primary objective.

The trade in technology, in patents and licences, is the most rapidly growing area in international trade. The U.S.A. has an ever growing substantial net technological export balance. Japan with its about $250 million annual deficit on technological import belongs to the group of countries, including Canada, which has an ever widening net technological import balance of trade.

To gradually reverse this trend in Canada there is, against the background of these facts, but one solution, to create in Canada the proper environment to attract to an ever increasing degree: (a) inventors, the creators of new technologies from all over the world, including Canada to establish their basis of operation in Canada; (b) new industries, based on new technologies, to establish in Canada production facilities as a primary export base; and (c) to induce foreign parent companies to switch to their Canadian satellites the development, production and world wide commercialization of new technologies to their Canadian base.

Our brief to the Special Senate Committee on Science Policy suggests one possible way

of adapting and channeling our present science policy towards the above desirable objectives.

The Chairman: Thank you very much, sir. Mr. David Golden has been with us before in another capacity. He is coming back with his main function in life now, as President of Air Industries Association of Canada.

Mr. D. A. Golden, President, Air Industries Asssociation of Canada: Thank you, Mr. Chairman and honourable senators. The Air Industries Association of Canada has already filed a brief and I do not propose to read it, but I would like to introduce the other members of the Air Industries Association who are with me today: Mr. Sam Roth, CAE Industries Electronics Division, Chairman of the Research and Development Committee of Air Industries Association of Canada; Mr. D. R. Taylor, President of Aviation Electric, and a director of Air Industries Association; Mr. E. L. Smith, Vice President (Engineering), United Aircraft of Canada Limited and Vice Chairman of the Research and Development Committee of Air Industries Association and Mr. R. J. Ross, Chief Development Engineer of Canadair Limited, and a member of the Research and Development Committee of Air Industries Association of Canada. I am happy to introduce the Vice President (Operations) United Aircraft of Canada Limited, Mr. R. D. Richmond.

We do not have any prepared statement, Mr. Chairman, other than the brief which we filed earlier. We are available for any questioning which honourable senators may like to direct our way.

The Chairman: I suppose it is a little bit too early, but I wonder if Mr. Richmond would be ready to make a brief opening statement to the committee before we go on with the discussion.

Mr. R. D. Richmond, Vice President (Operations), and Member of the Board of Directors, United Aircraft of Canada Limited: Yes, thank you. I apologize for interrupting your proceedings. There are, I am sure, several reasons why research and development is considered to be a good thing for the country. In our context I am going to speak directly to the one aspect of industrial development and confine myself to it.

Those of you who have had an opportunity to read our brief will see that we limited our discussion to one of the development of a particular small gas turbine engine, which is known as the PT 6. This is one of our activities, but it is also the major activity which absorbs most of our research and development talents. This engine is developed as an aircraft engine and when it was conceived in 1958 it was directed towards a market for utility and what are known now as business aircraft. At that time there was only one competitor in this particular power class, with about 500 horsepower. This was a company located in France.

Subsequent to our launching of the program, we picked up a United States competitor and latterly we now have one in the United Kingdom. I think that in spite of this we have been able to capture about 75 per cent of the market for this class of power plant and have produced about 3,050 of these engines.

This is just background information incidentally. I am not here to give a sales talk on either the engine or the company.

The Chairman: It is free advertising, but it is not very effective.

Mr. Richmond: I suspected as much. I am sure that we all appreciate that any successful enterprise has two basic ingredients in it, knowledge and resources. In the case of knowledge in our business it has to be on several different levels or disciplines. There is technical knowledge, marketing knowledge, manufacturing, and of course management knowledge. In this area we were greatly helped by our parent, United Aircraft Corporation of East Hartford, Connecticut, which initially licensed us to make some of their old engine parts. The relevance of this is that we had an opportunity to master some of these skills and techniques on their products prior to having to launch our own. Subsequently, we also had an opportunity of training a nucleus of technical people in the development business at their facilities.

In the marketing field we have also had the benefit of their experience and help on a world-wide basis. This is a continuing thing. It has not just been what you call a "one shot" but it has gone on and will continue we hope for some time. Also, a characteristic of our business is the fact that we require continuing assistance from not only our parent company, but also require the continuous use of resources to establish facilities and to continue to develop our product to meet an ever changing market condition. As an example, we not only find that our development cycle

goes on past the point of the delivery of the engines to the customer. We have to continue to increase the reliability of the product and to meet the demands of competitors from these other countries in terms of ever increasing requirements for more horsepower and lower fuel consumption. We need the ability to be able to have some flexibility in our business and to be able to deplore these resources with a very quick response.

I am sure that I am not saying anything new when it is recognized that no business or company is a master of the particular environment in which they work. It is exceedingly important that there be some flexibility in the way funds are made available, both from the company's generation of these funds and also any that might become available through government assistance.

We have another characteristic in our activity which also has some bearing on the research and development aspect. We have to be in a position to produce what you might say is an excellent product, not just a good product. One of the reasons for this is that aircraft engines traditionally have been bought in the more highly industrialized countries from domestic suppliers and, specifically in our case, from France, the United Kingdom and the United States. These particular countries are also attracted to us for the marketing of our engine and particularly, of course, the United States. As an example, we currently are supplying engines to one major Canadian airplane manufacturer, De Havilland, for their successful airplane. If we did not have an export market to sell in we would be in a position where we would have to sell the engine at probably an uncompetitive price or perhaps, to put it another way, we might not have a market for our engine. Currently we are dependent on approximately 77 per cent of our outlet for these engines outside Canada and primarily in the United States.

I have made quite a long statement here. It is really to give some background for the type of thinking that we do by choice—or sometimes think we are forced into—in projecting why we are researching and developing aeronautical gas turbine products.

In closing, the point that I should like to leave with you is the very important one that businesses or companies cannot be rigid in their thinking. They have to be flexible and be able to respond to the ever changing market conditions. Consequently, in regard to sources of funds, government should also be flexible. There should not be so much concern about the basic conditions on these funds or rigid ideas about what the percentage of the shares should be between the government and the company. They should be flexible enough to take into account specific circumstances that might occur. Maybe it should only be 20 per cent funding in some cases but in others maybe it should be 100 per cent. If the risk is worth it in a particular company that can attract this business, which in turn means increase in gross national product to the country and an inflow, in our case, of United States or foreign exchange, then there should be a willingness to appreciate all of this and judge each case on its merits. I am not saying that our company in particular should have one level of funding and somebody else should have a lower level. What I am saying is there should be a broad band which should be used for judging these particular applications.

The Chairman: Thank you very much. Now we shall go into our question period. Who is going to be the first. Senator Robichaud?

Senator Robichaud: Thank you, Mr. Chairman. I can at least start the discussion. In that case I shall direct my first question to the representative of Bobtex Corporation. I notice in their brief it is stated on page 5, paragraph 8:

> This brief has been prepared by two inventors with a background of extensive experience in large-scale international invention industry.

I may also mention, as it is stated in the brief, that we have heard very little so far from inventors or people who call themselves innovators. This brief, in stating the situation in Canada, says something like this:

> Even in the case of Canadian inventions, under present conditions it would be against fundamental economic laws to choose Canada as the world base for such new industries...

Would the witness expand on his own experience? For example, what kind of invention is Bobtex involved in, and why did the principal of this company, notwithstanding what is said in the brief, that Canada should not be chosen as a special base for such operations, choose Canada for his operations?

Mr. Bobkowicz: I emigrated with my family to Canada about 20 years ago. I had a very

large business in Europe in international trade in textiles, raw materials, machinery and chemicals. I did very well. I came to Canada with money. I travelled all over the world in order to decide where I should go and finally chose Canada, because of the reasons I mentioned in my brief. I wanted to come to a country where the future is more secure than other countries.

While in Canada we have been developing and pursuing our ideas in changing the 3,000-year old system of spinning. The technology of spinning was based on so-called cohesion forces and we came up with a new idea that could change entirely the system of forming a yarn and forming a weave. This started up in a small garage in Westmount in Montreal and under very difficult conditions. The question was, how do we proceed with the implementation of something which will be tackling one of the biggest problems, because textiles are the second important consumer item for man.

Right from the beginning we ran into one difficulty after another. An inventor experiences in the first years the feeling that he is crazy, cuckoo—that is the first reaction. This is after a certain period of time and particularly after hearing experts say that what he is trying to do is impossible. We have spoken with very top experts even within my family. I had spinning managers who said, "Why do you try to change 3,000 years of technology? It does not make sense." So what do we do? I had my money and I was willing to put in substantial amounts, start to develop prototypes, experiment with it and try to get some money to finance it. In the first period, from a cold idea to the hardware stage, the risk is usually the greatest. You cannot easily find someone who will want to venture or to finance such an idea, but we tried.

The Chairman: Especially when you are supposed to be crazy.

Mr. Bobkowicz: Anything which is new is particularly so to the expert, because what is an expert? An expert is an expert of the past. He cannot judge the future very well. He does not see and he has not the vision. Mind you, I do not speak about all experts and I do not want to offend anybody.

We had a difficult time to start out, but we were sure about what we were doing. The first thing that we did, of course, was to search patents and find out if someone had the same idea. We investigated patents all over the world.

Senator Yuzyk: How long did it take to get these patents?

Mr. Bobkowicz: Well, the patent; that is another story.

The Chairman: He has not reached that stage yet.

Mr. Bobkowicz: In the United States it takes approximately six or seven years to get the first reply from the Patent Office. In Canada it is faster, because it takes about three years. We had 26 countries covered with our patent. We have spent a fortune on the patents only. One patent alone will cost at least $1,000. We became our own patent lawyers in order to save money. We studied it and prepared it.

After our patent appeared we said, "Now it is time to find out who will finance us and help us." A great deal of money is needed to put through a technology of this importance. This is a typical case of how new inventions start. Where do we go? First of all we went to some of the large firms in Canada—I will not mention names—and we ended up with an American firm. The Canadian firms were not at all prepared to venture into such an idea. The next step was to file an application to the National Research Council, and there we found a response. It is only because of the National Research Council that we are still with our invention in Canada.

You ask why I wanted to do it in Canada. It is because I am a Canadian. Whatever I can do I want to do it in Canada. We progressed with our invention, and then we found open-minded investors. Mr. Michael Boyd took care of the financing. That was a very difficult job to do. We got enough money together to start our company. We were gradually able to prove that we had something worthwhile to offer. No one would believe us, even the biggest companies. The textile mills, as such, were more shortsighted or more conservative than any outsider. They could not believe that you could do the same work without all this complicated machinery and that it could be done in a simpler, cheaper and much better way. After we got the first money we developed further and then we had propositions. Standard Oil's first proposition was, "How much do you want for the invention?" We said the invention was not for sale, that we wanted to establish a joint venture. "No, we do not do joint ventures; this is not our policy." I said that my policy was not to sell the invention. We did

not reach an agreement and so we realized that we almost had to depend on ourselves, our own means and ingenuity. It was a very hard time because I came to Canada with money and I allocated one-third of my holdings to this, which was quite a lot of money. Gradually we built up a first class scientific team in Montreal. We have succeeded in proving our process. We have built the first prototype machines and are showing them now on a test basis to various clients. We even have orders already, because some American firms of spinners walked in and asked about our patents. Now we are getting enquiries from all over the world almost, because people got intrigued with this.

At a certain stage the Aluminum Company of Canada was interested—of course, we might use more aluminum in our machines—but later on they realized that it isn't only the aluminum involved, so they said they wanted to be partners in it. They became partners and we have a very, very pleasant co-operation with Aluminum Company of Canada and we are now set to go.

The potential of what we are doing is so large, it involves not only putting up a factory for making the machines for export all over the world, but who will exploit the new technology first? We have no possible way of forcing Canadian textile mills to do it. It looks to me that probably foreign firms will jump on it first.

We showed it first of all to Canadian firms; they showed great interest, and so on, but nothing else. I believe that they would just like in this case to have some support from the government to go into such a venture. It is understandable; this is done in England, for instance. With a new process and technology in the trade the spinners have been very conservative there; they wait a long time to invest their own money. So the English government purchased ten machines or so and said all right, those machines we bought we will give to you for testing; find out about them, let us not be latecomers in the new age technology. It could be done here the same way, but it looks as though the first machine will start to operate in the States; that is except for the ones in our lab.

We have the yarn, we have the machines and there are other new developments involved, because once you start in one direction you go on the main avenue then you find side avenues. Very often the side avenue appears to be much more important later on than the main avenue. So we had to cancel almost all our achievement up to this date and go to the new avenue. It would be a fallacy not to go, because it would be a big short cut. So finally, who will benefit from a new invention? We have to serve world markets. That means that we have to be in the most competitive situation. Let us not fool ourselves, we have patents, we have many patents, but we have to be competitive enough at the same time to meet all these huge old-established textile machine manufacturers.

We were told in Canada that we cannot build a spinning machine of this type; we were told go to the States to build them, to the textile machinery manufacturers. We said we don't believe that we cannot build it here; we built it here in Canada with a team of engineers and anybody who wants to see them, please come and see them in operation.

The question now arises, where do you put up the first machine factory to serve the European market or the South American market? We have to get the support of tax incentive, because the technology is changing so fast and we have so much to reinvest. That is the reason why I propose two practical approaches: one is to help the inventor to get started in Canada. If we cannot help him to get started in Canada, we cannot get new technology into Canada, we can only get developed technology for which we have to pay heavily. When it comes developed it costs a lot of money, so we have to start. This has been proven in our case; we have started in Canada and we believe this is going to be arranged on a simple basis without government money by putting up an insurance plan which will cover part of the risk of an invention like it is covered in the export business. This will work and it is not complicated, it is simple. The private sector will then see the risk is taken away and be able to finance it. Capital will eventually be willing to take this gamble, but not 100 per cent.

The Chairman: What will be the impact of this new machine? Will it be in terms of reducing costs or reducing the labour input?

Mr. Bobkowicz: It will reduce the phases of processing yarn from bale to yarn. There are many, many phases involved in the present system. They are interrupted, which means a discontinuous process. In our case we start with the bale and we can end with the yarn fully automatically, and with only two machines. We convert the yarn at speeds

which are ten times higher than are achievable at present. By virtue of this we have, of course, labour savings and raw material savings. Because we are not restricted to any particular type of fibre we are fibre-independent in respect to the machines. You have to have different types of machines to spin coarse wool, fire wool, fine cotton yarn, or coarse cotton yarn. To spin jute, you have to have a special kind of machine, and so on.

In our case we are independent from the fibre and we are following a trend that means we have arranged a marriage between the past commercial system and the advanced extrusion polymer system. We combined it. We have had advisers at our disposal. One of these, for instance, is Professor Mark, who is called the father of polymer science, to whom we went in Pittsburgh. By the way, we stumbled on him in the Expo Exhibition lecture and he told something of that. I said to my son and Mr. Hyland I would like to pick this fellow's brain. They said why don't you hire him? I said well, I cannot hire him, so they said all right, Alcan will pay. This cooperation started with Mr. Mark advising us closely and the team in our lab is on a very high level.

I do not think there is anything like it in the world. We attended an international scientific meeting in Princeton recently to find out whether there is something like this in our industry elsewhere. We found out that there is not.

The potential of this, the savings, the flexibility, the savings in the raw material, the savings in labour, in the flexibility, will make this process the leading system of processing of fibres into yarns. That is so large that we now have to keep it completely in Canada. Normally in our case the inventor would have to say all right, I will set up plants, one in the common market, one in the South American market and one maybe in the Far East or Europe. With the proper tax incentive which would pull back completely everything to be reinvested for expansion, Canada today could be the main base for the whole world. That would apply to many of such cases practically. We are proposing a very practical way of approach, which we have tested and know works. Why I say it will work, honourable senators, is that before the war I was very active in Poland. We had to build a new port from nothing. I was an adviser to the government and was decorated with the Distinguished Service Golden Cross for it. There was the Minister of Trade and Commerce and we worked out an incentive scheme. Within a period of five years we had one of the leading ports in being, not only in respect to shipping, but also in trading. What is the use of having only shipping without trade? This is the most profitable business, so this worked.

The Chairman: Here we have the contrary; we have trade without shipping.

Mr. E. Bobkowicz: Well, that is the same. We should stimulate. We should understand what is needed. When we know the problem in research we have 50 per cent of it solved. We have this problem all the time.

The Chairman: I suppose that we should come back to your more concrete proposals, but I think it was interesting to get the background of this for the moment.

Senator Robichaud: Mr. Chairman, while we have this background I notice that Mr. Bobkowicz has mentioned the patent end of it. There is no doubt that this is a time for industry where patents are very important. I have noticed that you have stated in your remarks that in your experience with the United States it would take as much as seven years to obtain a patent and you have given three years as being the case in Canada before you can get a reply.

Would you have any suggestions which would have the effect of improving our patent system in Canada?

Mr. E. Bobkowicz: To be very frank, in Canada particularly we have been called into the examiners from time to time and we found a very, very co-operative response. It goes much faster than in the States.

Of course I cannot propose any changes here with respect to the United States patent law, because there it is really very involved.

The Chairman: We will let them worry about it, but it is interesting to hear you this afternoon say this when this morning you were told that our patent system was probably one of the worst in the world.

Mr. E. Bobkowicz: Maybe from the legal side, there is another thing from the patent side. Actually our tax law and patent law, maybe not the patent law as such, is punishing the inventors.

To give you an example, when I created my own company, Emilian Bobkowicz Limited, which was later on joined with the Aluminum Company of Canada, there is a

law that if any inventor sells his idea to an outsider he can sell it for $1 million and he does not pay any taxes. If I transferred my patents to my company where I am in control, this is called arm's length, so they say you cannot do this. That means that if I want to develop it myself I am punished, but if I give it to somebody else I am getting a premium. This is wrong, because this should not be the case. We should give the premium to the inventor, not to the buyer of the patents. I am actually encouraged to sell. But this is a minor point.

In respect to the patent law in general, I am not such an expert as to be able to say what should be done to accelerate it. It is too long. There is one thing, until you get a patent in Canada anybody can start to infringe it and then you have no redress against him. This is very bad.

Dr. A. J. Bobkowicz, Vice President, Research and Development, The Bobtex Corporation Limited: I want to add one point: in terms of international patent law, we had one case in Japan where we waited 13 years for a patent.

Senator Robichaud: And by the time you got the patent was it still effective, or was it too late?

Dr. A. J. Bobkowicz: Oh, yes, it was still effective.

Senator Robichaud: Mr. Chairman, before I shift to Air Industries, I have one remark to make in connection with paragraph 24 on page 14 of the Bobtex brief, where it says that, referring to direct lending through existing or new agencies:

> To encompass these aims, it is natural to wonder whether the research, talent and experience presently available in the Industrial Development Bank could not be specifically channelled into this area of credit insurance.

I would hope that Mr. Bobkowicz would have more influence with the Industrial Development Bank in this regard than any of us have had so far.

Mr. E. Bobkowicz: Actually, I went to the Industrial Development Bank in the very beginning for assistance. I presented my case and a description of our first year's development. I remember the name of the man, Mr. Noble. So I was told yes, we finance, of course we help people like you to put up a new industry, but you have to be developed already. So I said then why do you call yourselves the Development Bank? If I have already developed a project then I do not need you.

What we need is support when we are in the phase of development. Then we would attract outsiders, because there are many inventors who would come to Canada if there were an incentive. We could attract a lot of people to Canada just by giving them some incentive, at least the possibility of financing. This should not be through government, nor through the suggestion I made, not just to go from one institution to another and to be looked upon as a crank. The private market will take the rest of the risk. The insurance basis will cover any losses just as in the case of the export insurance credit. I could not export anywhere before the export insurance credit was introduced. An exporter is not a financier. He cannot afford to produce a product or to finance foreign markets. So the export insurance credit took out this risk and the exports started to move.

Senator Robichaud: Mr. Chairman, my first question to Dr. Golden would refer to page 2, referring to the background of the company, where it is stated that:

> The steady growth of the industry within this environment is due to its ability to compete in the international market. In 1967 and 1968 some 60 per cent of the total industry production was exported. This is the highest percentage export of any aero space industry in any country in the world and this industry is now Canada's third largest manufacturing exporter.

Could Dr. Golden give us an idea of what has been the average rate of growth in the export market of the production of this company in the last five years?

The Chairman: Of the total industry?

Senator Robichaud: Yes, of the industry?

Mr. Golden: Yes, senator. First of all I would like to correct the statement on page 2. We prepared this at a time when we only had the estimates for 1968. We now have the total figures. In fact, in 1968 not only did we export more than 60 per cent, we exported more than 70 per cent of our total production. At the time that we prepared this brief we

only had an estimate. The actual figures turned out to be higher. We do have the figures for sales and exports.

In 1963 total sales of the industry, which we call the Canadian aerospace industry, were $550 million, of which exports represented $234 million. In 1964 total sales were $588 million, of which exports were $284 million. In 1965 total sales were $541 million, of which exports were $251 million. In 1966 total sales were $594 million, of which exports were $300 million. In 1967 total sales were $660 million, of which exports were $402 million. In 1968 total sales were $750 million, of which exports were $559 million.

Senator Haig: Mr. Chairman, may I ask Dr. Golden to explain what avionic products are?

Mr. Golden: It is a term which is becoming one more widely used than used to be the case. Airborne electronics used to be given the generic term avionics, but I am afraid it seems to be covering a lot more electronic products now.

In our industry when we talk about Canadian aerospace statistics we include aircraft, aircraft engines, components, accessories, ground support equipment and avionics, in which we include electronics as they relate to aircraft.

Senator Haig: Thank you.

Senator Robichaud: Regarding this increased production and also increased export, could you give us an idea of what percentage of this growth has ben commercially oriented, compared to the growth for military purposes?

Mr. Golden: I am sorry, senator, I cannot give you accurate statistics.

Senator Robichaud: No, just an estimate?

Mr. Golden: It is true to say that in recent years the increase in sales and the increase in exports has been concentrated more in the commercial area than in the defence area. The percentage of our total production and the percentage of our exports which is in the commercial area has been growing faster than the other.

Senator Robichaud: I also noted that your brief, which you stated yourself was purposely very brief, does not mention the relationship between government, industry and university in research. In comparison to the pulp and paper research institute, which really operates almost jointly with the government and the universities, could we have your comments regarding this type of co-operation?

The Chairman: You have a very different type of association. This is not a research association.

Mr. Golden: The Canadian Pulp and Paper Research Institute is actually an institute which does research. The Air Industries Association of Canada is a trade association, consisting of about 90 companies in the aerospace industry, but we do not perform any research or own any labs or do anything like that.

Senator Robichaud: But what are your comments on the relationship or co-ordination that does exist between industry, university and government in research?

Mr. Golden: We have got comments on that and I think I will pass. Perhaps Mr. Roth, the Chairman of our Research and Development Committee, will speak to it.

Mr. S. Roth, Chairman, Research and Development, Air Industries Association of Canada: We make reference on page 4 of our brief to the expenditures by government in R and D with respect to government, industry and universities. In particular we quote that of the $351 million in government R and D expenditures in fiscal 1968, the figure from the Fifth Annual Review of the Economic Council of Canada, 69 per cent was spent in government research laboratories, 16.5 per cent in universities and only 14.5 per cent in industry.

The point we are making here is that we believe that the industrial percentage in Canada is strikingly lower than in other countries. We quote as an example the 65 per cent of every tax dollar spent in industry in the U.S. We believe that there should be a substantial increase of government research and development expenditures in industry. It is this expenditure which provides the innovative product development which directly provides assistance to the economy of the country.

Senator Robichaud: I must apologize. You did cover that part of it.

The Chairman: I wonder if you could list for us the factors which you think were responsible for this increase in total sales, increase in exports in your industry and the part that research incentives have played?

Mr. Golden: Yes, we will mention some: there is no question that the government development votes have been extremely helpful in our industry. It would be quite wrong, despite the fact that we have some critical comments to make about these votes, to overlook the very great benefit that they have been. There is no question that the production sharing arrangement between Canada and the United States has been extremely helpful. Although initially these arrangements related only to military products, in may cases this has provided for the movement of technology into Canada based on a military product which is now being applied to a commercial, civil product. The operations of the Export Credit Insurance Corporation are, of course, extremely important in the expansion of exports. Then there are one or two very special cases. The very large subcontract orders placed by Macdonald, Douglas in the United States with its Canadian subsidiary in Malton, Douglas Aircraft of Canada Limited, where they had a very large piece of every DC-9 that was built and exported had a very great effect on the 1967 and 1968 figures. The tremendous surge in sales of Mr. Richmond's PT-6 engines in United Aircraft and the De Havilland Twin Otters are very largely commercial programs.

Would any of my colleagues care to fill in any of the points I have forgotten?

The Chairman: Perhaps Mr. Richmond will comment?

Mr. Richmond: With respect to our relationship between the commercial and military sales of the PT-6, it has been about 85 per cent commercial up to the end of 1968. There will be some change in this through 1970, but it will still be predominantly commercial customers who will take this engine.

The Chairman: How did your project develop? As a result, of course, of the experience that your parent company allowed you to take, but do you feel that these government incentive programs are very helpful in your case?

Mr. Richmond: There is no question, there would not have been a PT-6 program without the assitance of the federal government. I can say that categorically. We have spent on the development of this engine, this is total development costs through the end of 1968, about $42 million. During that period we got just under $13 million of direct assistance on the R and D phase, which is about 30 per cent. In addition to that, we received about $6 million under the defence industry modernization vote, of which, as you know, 50 per cent is repayable over a five year period. I think what perhaps we are all saying is that, at least I guess I should say what I am saying for the company here, I get a little mixed up with the industry...

The Chairman: You are part of it.

Mr. Richmond: ... is that although we have received this amount of assistance and without it there would not have been a program, we find that because we have been successful in attracting this amount of business and that is the reason I emphasize why we do research and development, there is no other reason we do it, we find that we have been in a position where there are new opportunities for us which we do not want to refuse. You never know if you opt out of a situation whether you may be putting yourself in a position where it is not just that business, but it is follow-on business that you may not be able to get. You try to handle everything that you might say comes your way. It is a little bit like doing an Indian rope trick to continue the development of this product or products as they are now turning out to be, and at the same time generate enough revenues to support them. It is perhaps an odd situation, in that the more business you get, the more difficult it is, because you cannot place this business just where you would like it. You have to take it or not take it, as the opportunity arises. This is what I meant when I said earlier that there should be a higher degree of flexibility in the way the government looks on this. I think particularly of this concern about repayment. The government really gets repaid if the program is successful in terms of employment, taxes that the personnel and the corporations pay, and so on. I don't have to go into this. There is a great multiplier factor which I am not really competent to speak about. It is a very difficult situation to say no to something and at the same time you do not want to say yes if it is going to get you into trouble.

Mr. Roth: Mr. Chairman, just to add some statistics to those that Mr. Richmond provided, if I could wear my company hat for a minute: CAE have sold some $23 million worth of simulators in the past years. These have all been commercial. The point I would like to make here is that the technology

which allows us to compete in that international marketplace to sell these simulators stems from a military program which we were involved in earlier, in particular the F-104 business.

One other point I would like to make is that that training grant, if you like, and that ability to do non-recurring development for military programs is tending to disappear, which is one of the reasons why we would like a reassessment of the direct government assistance.

Dr. A. J. Bobkowicz: I would like to comment on the question Senator Robichaud raised about university, industry and government co-operation. I could speak from experience in our company. We are participating in the National Research Council program which was initiated this year. They have provided a very effective tool for providing government money to industry. This then utilizes that money to pay professors who are in the universities and who are asked and paid to work in the laboratories of the companies. This is for the period of the summer or on a part time basis year round. This is particularly useful to small companies which are being supported by the National Research Council, which are in need of additional brain power and technological upgrading in the overall company staff. The source of these brains in the universities then is becoming available to industry where it needs it most, that is in the application of government money, utilization of university manpower as well as their facilities very frequently, and the exposure of university professors to industry where the industry benefits as a result. It is a two-way street and from our experience it is working very well.

Senator Haig: Do you take any graduate students, or near graduation, into your firm for summer periods, or for weekends, something like that?

Dr. A. J. Bobkowicz: As a company which has a total of approximately 25 employees, we have three summer students.

Senator Haig: That is a good percentage.

Dr. A. J. Bobkowicz: We are employing at present two professors as well as the consultant that we mentioned on a similar program basis. The American ones we pay for ourselves, of course.

Mr. Elvie L. Smith, Vice President (Engineering) United Aircraft of Canada Limited: I would like to express a concern that we have about the trend of university expenditure. We have been expending increasing amounts of our tax money in the country, of course, on education and we wonder now if perhaps some of this is not getting out of hand. I refer here to some data which was published in a document called Background Studies in Science Policy by Messrs. Jackson, Henderson and Long. There they examined the trends in expenditures in R and D in industry, government and universities. They assumed that the total country's expenditure might go from today's less than 1½ per cent of GNP spent on R and D to 2½ per cent by 1978. They further assumed that the trends which are evident now in university and government expenditure would continue and that the remainder of the money would be spent in industry. This leads to the result that between the years 1966 and 1978 university expenditure would go up from 24.6 per cent to 38.9 per cent of the total country's expenditure on R and D. Government would go down slightly, from 33 per cent to 31 per cent. Industry would drop sharply, from 39 per cent to 27 per cent. We consider that this is a quite wrong situation in a country that is saying it is seriously endeavouring to stimulate industry R and D and the production that goes with it. So we believe that this trend should be changed. Unless we build and augment substantially the total expenditure the only other option is to reduce the rate of expansion in the university expenditure and hand some of this money to industry to aid in new production.

The Chairman: Since Mr. Golden is a member of the Board of Carleton University, I am sure he has taken a good note of your comment.

Senator Robichaud: I have another question for Mr. Richmond: We were pleased to hear of the success of United Aircraft Corporation in innovation, manufacturing resulting in increased exports, also for giving us some suggestions such as a larger degree of flexibility in government program in order to assist in research. My question is a related one: Would the company have been able to successfully design, manufacture and develop the PT-6 engine without the import of technology from its parent company in the United States?

Mr. Richmond: That is a hard question to answer, of course it is a matter of timing, but I think the answer probably is no, in the time frame that we did it in.

Senator Robichaud: Did you get a major part of your assistance from the parent firm, or was the major work done in Canada?

Mr. Richmond: No; the development work on this engine was all done in Canada. The training of a nucleus of engineering people was carried out at United Aircraft's plant in East Hartford prior to the launching into the development of the PT-6. This was a matter of about a dozen people. Subsequent to that there have been and continue to be specific instances where we can get assistance on request on specific problems. In addition to that there is a great backlog of information and experience of things like materials as an example. These are very fundamental things which a company starting from scratch could not possibly accumulate in the time that is needed to bring forth a program successfully. Just to set the record straight, the development of the engine was all done in Canada in our facilities. I would like to belatedly introduce the two other members of the group here: Mr. Miles Beech, the comptroller of the company, and Dr. el Baroudi, manager of business planning.

Senator Kinnear: Here on your technological trends you say in the building of your new engines you are going to run into a great deal more pollution apparently. You give the reason for clearing up the pollution, the reasons why you cannot clear it up. Have you started to deal with that?

Mr. Richmond: I do not believe that we meant to imply that we were causing any pollution now.

Senator Kinnear: Do you mean to say that your engines are so good that there is no trouble pollutionwise?

Mr. Richmond: No; fortunately they are small enough that they really do not generate that much in the way of pollution. What is intended here is to indicate some of the areas where there needs to be continuing and further work, particularly if these engines are going to operate as many people think they will in the future in and around populated areas. This is a philosophy that is developing, where the larger airports will be set up outside the main population centres and smaller airplanes will be used to carry the people from the main distribution centres into the small fields near the areas. This is what is meant here. The word pollution also applies here to noise.

Senator Kinnear: Oh, yes; that is part of it. You say that here too. When are we going to get better transportation service from the larger airports we have today with smaller planes to various areas, like the Niagara district?

Mr. Richmond: I see Mr. Golden sitting here, maybe he will answer that.

Mr. Golden: It is the best solution in the world; there is no question about that.

Mr. Richmond: This is now taking place in certain of the major population centres in the U.S., particularly around Los Angeles. There is quite a lot of activity with this concept.

Senator Kinnear: Well, it is a serious transportation problem and I think we are into great trouble in Canada now needing that service. I was hoping that you would say you are going to get at it right away.

Mr. Richmond: The products are there. It is a matter of convincing people to use them and having the airports, of course.

Senator Kinnear: I hope you don't mean the very small aircraft that just carry four or five people.

Mr. Richmond: No, the airplanes that are currently in use for this type of operation carry about 18 passengers.

Senator Kinnear: I am still disappointed.

Senator Robichaud: You are prepared to supply the tools to do the job?

Mr. Richmond: That is correct.

Mr. Golden: I think, senator, that one of your witnesses on Friday was Mr. Boggs, the president of De Havilland. I do not know the details of the aircraft on which they are working, but the DHC-7, I think, which is the aircraft which presumably will be their next project, is designed to have four PT-6 engines and to carry 40 people.

Senator Kinnear: That is much better.

Senator Phillips (Prince): With respect to the transportation problem that Senator Kinnear brought up, what about the use of heli-

copters for this? I do not know whether or not your firm would include the new helicopter company opening up in Picton as part of your group.

Mr. Golden: I would hope so. Mr. Richmond knows more about helicopters than I do.

Senator Phillips (Prince): Are they not in operation in the United States for that very purpose?

Mr. Richmond: Yes. I hate to say this, because United Aircraft is also in the helicopter business. We sold several of them up here for the Royal Canadian Navy. The problem to date has been that the operating costs of helicopters are such that the commercial operator cannot attract passengers at the fare necessary to pay for the operating costs and some margin. Thus the ones in the U.S., to my knowledge, are operating under a direct subsidy from the federal government, although I think that is phasing out, and what is starting to take its place is the subsidy from the major airlines. The reason for this is that the airlines will underwrite the operation of these helicopters on the basis that the customers will use the helicopter to get off at the main terminal to get to a major trunk line. It does not appear that within the present state of the art helicopters will ever be as economical to operate as a fixed wing airplane.

Mr. Golden: In fact, recently some helicopter services in the United States have been suspended and replaced by airlines flying aircraft such as the De Havilland Twin Otter powered by PT-6's.

Mr. Richmond: That is right. New York Airways is one of them.

Mr. R. J. Ross, Chief Development Engineer, Canadair Limited: I would just like to add a few words to those mentioned by Mr. Richmond concerning the aircraft needed to meet the ever-increasing congestion in the urban areas. The short take-off and landing aircraft has already made very sizable inroads in this area. As the inter-urban areas become more crowded then the needs are going to become more difficult, the space available is going to become more difficult. We shall probably find ourselves in a situation where just short take-off and landing aircraft may not be the total answer to the problem. We may need eventually to include in our system aircraft which can land and take off vertically. I am not referring here just to helicopters. Helicopters in themselves do have limitations with respect to the speed at which they can operate and then accordingly the productivity which they can generate. I am referring here to aircraft which are somewhat faster but can still operate vertically. Canadair has been engaged in the development of this class of airplane for more than ten years. Now, this work has been going on with the support both of the company and assistance from the Canadian government. We are already at the point where we have a successfully flying vehicle. I would simply like to put on the record at this point that we believe that this is a two stage operation where we have short take-off airplanes and eventually we will need vertical take-off airplanes in order to meet the total needs which are developing, especially as the urban areas become more and more congested.

Senator Phillips (Prince): By vertical take-off you are referring to jets?

Mr. Ross: In our particular case we use propellers. We tilt the one wing, the engines and the propellers so that in a way it looks like a helicopter with some small sized rotors when it is vertical. In normal flight the wings tilt down and it operates and looks like a normal airplane.

Mr. Richmond: This opens up a whole new generation of aircraft which probably is best classed as hybrids. Some will have a configuration such as Mr. Ross has described, some will have rotors which look like helicopters but will have wings on them as well, and some will have jet engines which simply lift the aircraft vertically. The big disadvantage currently with the latter is how to deal with the noise problem in congested areas and the debris that gets thrown up.

Senator Blois: Mr. Bobkowicz, on your spinning equipment are you planning to put up a plant to do the spinning, or simply to manufacture the machinery?

Mr. E. Bobkowicz: Our purpose is to build the machinery and to make it available to everybody in the spinning business.

Senator Blois: I thought from what you said that one piece of your equipment would be too large for a small plant. You said something about it being a continuous operation.

Mr. E. Bobkowicz: Our process will actually for the first time in the textile industry enable—up to now the concentration in the

industry was due to the size of the spinning mill which was not economical if it was, say, below 10,000 spindles. So only big companies could afford to have a spinning mill. Due to this factor the weavers were not able to have their own spinning mills. First of all they would have to have a variety of yarns. This was more and more creating a situation where big spinners either took over the weavers or big weavers started to go into the spinning business. Now with the new system anybody, a small weaver can become a spinner. We can have a spinning mill in this room. He can spin any fibres. He can be very flexible. He can make his own yarn. We provide the technical know-how. We provide what he can do, but the ingenuity of the user of the machine will be the master of what he does, because we provide a tool that is so flexible that there are no limitations actually on what he can make on it.

Senator Blois: Would the machinery be terribly expensive compared with frame spinning or mule spinning?

Mr. E. Bobkowicz: You cannot compare the conventional system with our system. If you compare it with one part of the spinning mill, the mule or spinning frame, this is just a section of it. We substitute a whole section. So we have to look rather at the overall benefits. In respect to the investment needed, our equipment will need maybe one-third of the investment needed now per pound of output.

Senator Blois: Yes, but you are doing away with carding of all types; it would be one machine?

Mr. E. Bobkowicz: Yes, he can start up high efficient production right from one machine, which is not now possible. Then we intend to rent the machine.

Senator Kinnear: What will that do to the cost of the finished yarn?

Mr. E. Bobkowicz: Of course you have coarse yarns, medium yarns, different types of fibre.

Senator Kinnear: Comparing them with your other machines, is it going to raise the price of yarn?

Mr. E. Bobkowicz: No, on the contrary it will reduce the price of yarn. That is exactly what our process is doing. The competitiveness of the textile industry can be improved considerably. I believe that if this were applied properly in Canada we could switch around and become exporters instead of importers of textiles.

The Chairman: Exporters to Japan?

Mr. E. Bobkowicz: Yes, even to Japan. Because you see the labour content in our machines is such that we can compete. It is only a fraction of what it is in the conventional system, therefore we are not labour-sensitive any more.

The Chairman: But with all these advantages and after having discussed all these things with the industry in Canada, still there is nobody yet that you know of who is interested enough in your machine to buy it?

Mr. E. Bobkowicz: Oh, yes; they are interested, but—

The Chairman: They will be too late?

Mr. E. Bobkowicz: Yes sir, but they are not in a hurry and they are looking to Ottawa and to Quebec for financing, and so on, which is actually the right way to do it.

The Chairman: Have they made applications to Ottawa to get grants?

Mr. E. Bobkowicz: I would not know, but I think some of them, yes. I understand that there is one firm in Quebec who made some application. We ourselves made approaches to Minister Pepin and to Quebec in respect to assisting the spinners. We are still in talks, but the results are very slow.

The Chairman: If we were able to further reduce our import subsidies it would be very interesting I think.

Mr. E. Bobkowicz: That is what I have in mind. I am not speaking about the textile people here. To me the competitiveness is rather to assist the textile mill to buy new equipment and to be competitive than to put on an import barrier which will induce them to stay conservative.

Senator Blois: It would have the tendency of putting a great many people out of work, would it not?

Mr. E. Bobkowicz: It would actually increase the work. If one man in the world, let us say in India, the millions of people in India would buy one shirt more, that is to say if they could not afford to have two shirts instead of one shirt, we would have much

more. The consumption is actually growing fantastically due to the rising standard of living and the population explosion. The textile industry is facing a very large problem to be able to supply the future demand of the world markets. That is the reason why we believe that a new system must be introduced. The old system is out. It is not capable of further improvements.

Senator Blois: As far as the United States and Canada are concerned it would put a great many people out of work if they all adopted your system, thousands of people?

The Chairman: That would depend, of course, on the increase of demand both at home and abroad as a result of reduced costs.

Senator Blois: I can see that, but I am talking about directly.

The Chairman: For the same amount of production you mean?

Senator Blois: Yes, many, many people.

The Chairman: You said a moment ago that this would economize on labour.

Mr. E. Bobkowicz: To increase productivity.

Senator Blois: Oh, yes, I agree with that.

Mr. E. Bobkowicz: Increased productivity always leads to vast economic development. If we have lower productivity, we keep something which is stagnant.

Senator Blois: Take some of the cotton spinners in the province of Quebec. With your type of machine, as I understand it, the production for one unit of yours would be equal to perhaps 15 to 20 units that they are at present using. So that would cut out a great deal of labour.

Mr. E. Bobkowicz: No, that is one point I want to make. You see, a spinning mill of the present time which has, let us say a capacity of opening fibres, in our case if it has let us say 10,000 pounds of opening capacity it can produce 20,000 pounds of yarn. With the present process it would only produce 10,000. So the logical thing would be to apply our machines, not to reduce the labour force but to increase the productivity. We would put in these machines to increase the output of the factory without removing anybody from it.

Senator Blois: Yes, but we do not have the capacity to use it either here or in the United States.

Mr. E. Bobkowicz: I would disagree here, if I may, because in fact 50 per cent of the production in Canada is covered by import today. It is a tremendous field to eliminate many, many imports or, conversely, improve our export position in fine items. We could possibly not compete maybe with some of the imports, but we could increase our export in other items made by this process. So generally I rather think it will contribute more to increase employment than decreasing it, besides creating a new industry for making the machines. The machines will also have to be built by labour.

Senator Blois: Yes, but you are going to replace so many machines that have already been made by labour. I am not going to argue about that, it has no particular bearing on this, but I just fail to follow your argument altogether. You make one machine and say it is fairly simple and it would probably take, I think you said 25 men working, or something?

Mr. E. Bobkowicz: No.

Senator Blois: I understood you to say a small number of men. If you take the number of men who are employed in making the spinning and carding machinery in the United States, Great Britain, or other parts of Europe where that type of machinery is made, a tremendous number of men are used for that type of work.

The Chairman: I suppose we have no choice now that the invention has been made. If the invention is applied in other countries and not in Canada it will put more people out of work.

Senator Blois: That is right, it would help out the Indians and the underdeveloped countries.

Mr. E. Bobkowicz: The invention of the loom or of the mechanical system has not decreased, as was previously thought, the need for workers, on the contrary it has increased it considerably.

Senator Blois: It eased up a lot from when the women had to use the spinning wheel to make the garments.

Mr. E. Bobkowicz: In spite of this they have increased considerably.

Senator Phillips (Prince): If I may, Mr. Chairman, I would like to direct a couple of questions to Mr. Ross of Canadair. When the

Argus was in production I had the pleasure of visiting the plant on a couple of occasions. Their management mentioned the excellent co-operation they had received from NRC, particularly in meteorology, wind tunnels, and so on. Are you still receiving that co-operation?

Mr. Ross: Yes, Senator Phillips. This takes place whenever we have a particular need and we identify a particular problem that we are not able to solve with our own resources. We go to the National Research Council and if they happen to have expertise in that area then certainly they make it available to us. They assist us in the solution of our problems. However, these problems do not arise too often. There have been areas in the recent past where this has happened. We have a problem and the NRC has had a particular program and there has been a commonality of interest. We have been able to combine with them and they have done work which has led to benefits on our part. Certainly I would say that whenever they have something which is able to help us then they certainly offer it to us.

Senator Phillips (Prince): The second question, Mr. Ross, is that you were doing research on other types of manufacturing. I am thinking now of the machine for sorting mail, and so on. Its purpose was essentially to prevent the lay-off that occurs when a certain aircraft goes out of production. Are you still carrying on that type of research?

Mr. Ross: I was not involved with the program concerning the post office sorter. It did not come to a complete conclusion. I think the project was abandoned at some stage. We are not continuing in that particular area. We have not pursued other projects of a similar nature to that, although the people who were engaged on that have gone on into other product development areas.

The Chairman: I would like to ask a question of Mr. Richmond. You referred a moment ago to government incentive programs and asking for more flexibility. Since we have begun to receive representations from industry there has been one suggestion that we certainly make these programs quite flexible. That would be to go back to tax incentives rather than grants. Is this the kind of thing that you favour, or you support, or would you simply want to see the present programs being continued with more flexibility built in?

Mr. Richmond: I was really referring to the continuation of the same type of program that really had (a) more money available and (b) that it was allocated in a manner such that the consideration...

The Chairman: You are really asking for more discrimination in a sense?

Mr. Richmond: That is a way to put it, yes. Perhaps we could have a comment from Mr. Smith on this question. He attended a series of meetings in Ottawa where this question was aired.

Mr. Smith: We could make this as an industry comment in that, as Mr. Golden has said, the existing benefits have been very real. We have, however, as an industry been pumping so much of our profit into new product development that a tax incentive as such is not really adequate for the job. We hope to have increased continuous and direct assistance for research and development. This in fact is essential if we are going to take hold of the opportunities that are open to us since we are now trading effectively in the international market.

Mr. Golden: The development of major new products in the aero space field is an international matter. Consequently you have to see how these things are done in France, the United Kingdom and the United States. There is no such thing as a major new product in the aerospace field without very significant government support which cannot come only from tax incentives. They have their role to play, but there have to be real development grants as well if you are going to proceed in the field of a new major avionic system, aircraft or engine. That is the name of the game in the aerospace field. The advantages on the other hand are correspondingly very great. It is a high technology industry which can export and a successful product can stay in production for a very long time indeed.

Mr. Richmond: I might just add something to that. As I mentioned, we have three main competitors in this size of engine in the western world. Two of them we know receive a much higher level of assitance than we do directly. This means in effect that it is very difficult.

The Chairman: That is in Great Britain and France?

Mr. Richmond: Particularly. This makes it, of course, very difficult to be price competitive with these engines assuming that other things are equal.

The Chairman: Could you describe the differential or quantify it?

Mr. Richmond: In the case of one product in the U.K. it is a hundred per cent quantum right now. There is a reason for that. They have an in-country use for the engine. They are funding an airplane to use that engine as well and it will be used in a military application. The engines are really insensitive in the sense as to whether they are military or commercial in this power class. So they will, in fact, have a competitive product fully funded on the market in the next year and a half. In the United States it is a different situation. There is really no direct funding of commercial products, as you are probably aware. But the companies on the other hand enjoy a very large degree of military programs and, of course, there is a spill-over. There is a similar version of the engine competitive with ours which has been funded and there are families of engines in and around the power class which are under contract to the U.S. military. So that there is a continual interrelation of osmosis effect here on both overhead assistance and technology assistance that spills out from these programs.

Mr. Golden: Not only military, of course, but now NASA fully funded plus profit.

Senator Robichaud: Mr. Chairman, we have had evidence that there is no doubt that United Aircraft of Canada as a result of their innovation program have contributed largely in assisting Canada's balance of payments. This is particularly due to their large percentage of export. Can a company such as United Aircraft continue successfully to innovate regardless of development in other segments of the Canadian industry? For example, the materials industry? In other words, what other industrial sectors should receive encouragement to development in order to protect the development within United Aircraft?

Mr. Richmond: I would like to answer that in two parts. Firstly, I would like to reiterate what I was trying to make clear earlier, that there seems to be plenty of opportunity for these products, or variations of the products, or similar products of a more advanced nature. We have plenty of opportunities to sell in this market. It is a question of whether we can afford to continue to develop them at a sufficient rate, you might say, to attract business at the particular time it is there.

The second part of the question I would like Mr. Smith to answer, who runs our engineering organization.

Mr. Smith: The material area is one of the benefits of having a corporate parent. We have been able to get from our parent material knowledge as required, really, for the projects we have been on. We have planned and we do plan to continue to use that knowledge because it is available to us. We have specialized in our own research in terms of developing the aerodynamics of small scale components. We are now in a position to trade technology with our parent. This material question happens to be one where we do not anticipate doing any work, we do not anticipate needing to do work. The general answer to the question is that as far as small engines at United Aircraft are concerned we have in-house or in-corporation those researches going forward that are necessary for the next product.

Mr. Golden: What you also need for a successful exporting engine industry is a very good support industry, sub-contract, components, accessories. Mr. Taylor there can comment on that perhaps.

Mr. D. R. Taylor, President, Aviation Electric Limited: Mr. Chairman, I think this is an important point, because we all look upon these so-called large companies or prime contractors within the industry, which are relatively few in number, for the survival of the smaller companies in the industry which form a greater number of companies although smaller in total percentage of industry. Success stories like the PT-6 and the De Havilland Twin Otter are vital to the survival of many of the smaller companies who are active in the support accessories that go on to these prime products. Engines need pumps, fuel controls, ignition systems. Airplanes need electrical systems, hydraulic systems, wheels, brakes and under-carriages, and so on. Again it is the same type of technology. In this end of the business we need research and development. We must keep abreast of this state of the art. When the engine manufacturer comes along with his next generation of engine, or next sophistication, the accessory people must be in a position to respond. The saying is that the key to success is what the prime contractor is able to do.

Mr. Richmond: Mr. Chairman, I might enlarge a little bit on that. In the first few hundred engines which we built there was a so-called Canadian content of about 25 per cent. We currently are running between 70 and 75 per cent as a result of a program we have had to try and develop more and more of the Canadian suppliers. These are such as Mr. Taylor's company, as well as what we call just sub-contractors making parts for us to our drawings.

Senator Robichaud: So you are really getting some support in material?

Mr. Richmond: Yes, but I can give you an example of one place where we fail to get support, if you are interested. Many small companies, and I mean very small ones, of a hundred people or more, who are in the business of supplying parts are lacking in many of the management skills that are necessary if they are going to deliver these parts to the correct quality and on time when you need them.

Senator Robichaud: Are they lacking due to lack of financial support?

Mr. Richmond: I am sure there are some, yes, that are in that position. The point I am making now is that by management skills I mean the ability to control their operations when they are running a high volume of parts through. We made contact with the Department of Industry and suggested that as one way of being able to build up this base of small companies we would undertake to train them in the control techniques. They knew how to make parts, but they did not know how to make a lot of them and on a continuing basis where they were at a given time. We were received quite favourably on this to begin with. An arrangement was worked out whereby we would fund 50 per cent of this cost and the Department of Industry would fund the other 50 per cent. It was necessary for our people to go into their plants and run classrooms as well as setting up systems on how to control the operation. The first thing that they found when they went to get their funds was that this came under the heading of education. Then we were told that we had to go to the province; so we went to the province...

The Chairman: Or change the name.

Mr. Richmond: That was even thought of. We never did get this resolved so, quite frankly, we have done a lot of this on our own. We also, quite frankly, have not done as much as we would have had we had some support. This is really building an industrial base. It is just one example of the type of thing that is needed to develop more sophisticated industry.

The Chairman: I would like to come back to this proposal of an insurance scheme to finance the small innovator. How would it actually work? You explained a little bit in your brief, but would it work exactly like our export credit arrangement?

Mr. E. Bobkowicz: In a similar way. Actually I would visualize it in a way that an inventor who, like in my case, came with an idea. We already had some patents. He would come to this institution like the Export Insurance Corporation and say we would like to have insurance coverage of this. We might be able to get financing from some people but they do not want to take all the risk, only part of it. If you take, for instance, the insurance for export, you get only the guarantee, not the money. You are getting only the signature of the government, because the money is supplied by the private sector, or whatever means you have. It is not the government's responsibility to provide the money. So when I make such an application then, of course, this institution will check it, make an educated estimate as to whether this is a worthwhile invention. They might say that for the first year we are willing to give a guarantee of so and so and wait for the first year's results. That is often done also in the States on a contract basis, that the first year is the proof that the idea has merits. Then, having this guarantee, again the private investor who will finance it will also look into it, because he is involved in a 25 per cent or 20 per cent risk, so he also will investigate the feasibility. But all inventors at the early stage are rather fuzzy. It is very difficult to establish whether they have merits or not and to find out which one is good you have to go through a hundred. If several pay off, it becomes a profitable proposition anyhow. There is a gamble involved in every invention. Only experiment can show later to what extent it has merits.

The Chairman: In the United States there are companies like the American Research and Development Corporation which try to specialize in this sort of exercise. We have one apparently in Canada too, but it is not working very much. It does not want to take risks or it does not have enough money. We do not know.

Mr. E. Bobkowicz: Of course the risk has to be spread. At the moment there is a risk involved to you, you are dealing only with one party. Here in our scheme the risk is spread over many firms. It is more flexible. The inventor would then be responsible to find the money on the market himself, providing the government is willing to guarantee it.

The Chairman: Yes, but once he has a government guarantee it makes things much easier.

Mr. E. Bobkowicz: Yes, it will make it much easier, but still the private investor will look into it. If I go, for instance, with an export product to a bank and I have even the coverage—had that with Egypt, for instance. I exported some wheat and I had to find somebody who would take the rest of the risk, which I believe was 20 per cent. I was told, all right, we can insure this, but it is up to you to find the money. Our banks cannot provide you with the money. So we had to do it. So even at that time there was reluctance on the part of the bank in Canada. We could not find the money here so I found it in Amsterdam. We are providing a tool like a mortgage on a house. Supposing we had no mortgages now? Who would finance all these buildings? This is almost, let us say, mortgaging ideas. In my opinion this would be a very flexible instrument without involving government expenditure, only the risk. If our present government wants to spend, let us say in a certain field, $200 million or $100 million or $50 million, for $50 million you can only have $50 million of work or business covered. For $50 million of insurance you can have ten times higher output. This would be very practical. Those who finance such a scheme would have to pay an insurance premium. It could be 5 per cent of the amount. That would be the cost of the development of the idea. The government would get money back right away, building up a fund in case of a loss, in which case they recover from the fund. With the Export Insurance Company I understand those fears were exactly the same. What would happen if there were a loss? How can we then recover? Now it appears that they have an income, not a loss, despite the heavy risk.

The Chairman: The same thing applies with Central Mortgage. I think they have been able to reduce the premium on their insurance.

Mr. E. Bobkowicz: Yes; I had a Central Mortgage myself when I came to Canada. I bought one of the insurances; then I wanted to get out of this insurance because I wanted to take the risk myself, but I could not.

The Chairman: I have a final question. This has to do with the coordination of these various incentive programs, since you seem to advocate various incentive programs to fit different situations. It has been proposed to us that there should be much more co-ordination among these various programs. Centralization of their administration has been suggested, instead of having one in NRC, one in Defence Production, or two or three in industry. Do you have any comments to make on this, Mr. Golden?

Mr. Golden: It think perhaps some of my colleagues would like to comment. I should say, first of all, from our parochial point of view just thinking of the aerospace industry as such, this is not basically a major problem. Most of our activities in the development field relate to the Department of Industry, Trade and Commerce. They understand our problems. We would like more money and things like that, but they understand our problems and we do not on the whole feel that there is any real problem there. I think we would feel that research in the universities, that part of research in the universities which is funded by the federal government could probably be co-ordinated better by NRC. It may very well be that from time to time the various government agencies concerned should be talking to each other more than they do. Perhaps some of the in-house programs could be better related to what industry expects to achieve from them. My general reaction to that question would be that this is not a major problem in the aerospace industry. Now I will probably be contradicted by some of my colleagues here.

Mr. Roth: I think in general industry agrees that the existing administrative procedures are adequate. This does not mean that they are perfect. We have had complaints about the time it takes to get approval, which we would like improvement on. We believe, though, that because of the several different types of government programs, you mentioned NRC, there is DRB, DIR, and so on, there could be more co-ordination. We believe that this kind of co-ordination should be done by the Department of Industry, Trade and Commerce, who best understand our problem.

Senator Bourget: Should they be administered by a single agency? Do you recommend that? You, Mr. Golden, may have a different point of view because if you deal only with the Department of Industry, Trade and Commerce, that is different. For other industries who would be probably involved with some other departments or government agencies it may be that it would be better to have only one agency who would administer the incentive programs. I am not giving any details, but often we have been told that they are too complicated, paperasse as we say in French.

Mr. Richmond: There is probably some desirability in this. I do not consider this to be a major initiative. What I think perhaps does need some examination from the standpoint of co-ordination is firstly the distribution of the funds that may be available from the government, how they are going to be spent. If there is a serious interest in industrial development then quite frankly the industry is in a better position to spend this money to get a return. That is what they are interested in the return. A return for industry is a return for the country in terms of employment, exports, and so on.

The second point which I think needs some co-ordination is that which has been touched on, the various activities that are taking place within the different in-house activities in the government. It seems to me that although you cannot legislate research in any specific direction, or I do not think you should legislate all research into a specific direction, it is a question of priorities. Perhaps there should be a little more of the in-house activity directed towards supporting the industries' down-the-road activities, not what they are doing today, what they hope to be doing five years from now. I am sure this is not new. On the other hand, I think that you cannot be too rigid again and say that all in-house activity has to be in support of something. Nobody told Edison to invent the light bulb, for example. So it is a question of how you split it up. Right now I think it may be a little bit too heavy in the direction that it is not supporting industry's desires and wishes down the road.

Senator Bourget: Is it the same with the universities? That they are not conducting their work as much as industry would like them to to a certain extent?

Mr. Richmond: I guess we would answer yes to that.

Senator Bourget: I do not want to criticize the universities, but this has been said here, that they should work more closely with industry so that industry will get something out of their research work.

Mr. Richmond: There are two reasons for that. One is the benefit to industry. Secondly, they are training people presumably to go into industry. The majority of the people intend at one time or another, I would presume, to go into industry. If they are working in an environment in which there is no relationship to what industry is doing, it is quite a gap to bridge. The other reason, of course, is that industry needs these people.

Senator Bourget: The reason I am asking this question is that, as you know, the governments are helping the universities. In view of this we could in our report recommend that universities should do that kind of work that will help industry to put out some new projects or things like that.

The Chairman: I do not think we will be able to go very far in that direction of telling universities what they should do. You can perhaps adjust your incentive programs or your research programs so that they might be influenced that way.

Mr. Golden: Senator, it would be wrong to suggest that there is no such co-ordination, because it does of course exist. It is a question of degree.

Senator Bourget: What about the manpower? Do you find, or do you expect to find difficulty in finding qualified engineers and technologists to do that kind of research that you are doing?

Mr. Roth: We have not as a committee answered this question, but perhaps I will get the ball rolling. I do not think that the industry presently has a difficulty in acquiring qualified engineers and scientists. We recognize though that if we do not continue to have research and development programs to attract our graduates, then we are going to lose them. This again is an incentive to continue, an indirect incentive to continue research and development support. Graduates

leaving university with bachelors or advanced degrees are looking to do engineering and scientific work. If we cannot find it for them, they are going to go where it is.

Mr. Richmond: That leaves a gap, it is a two-headed affair. You have to have levels of skill, just like a book with a whole lot of leaves in it. You cannot use all graduates and you cannot use all men with ten years experience. So if there is not some continuity of taking these people in and they leave the country, then it is very difficult to get something started. You have to go out and recruit outside the country.

Senator Bourget: What is the percentage of scientists in your industry who are Canadian-born?

Mr. Golden: There are no such Association or industry statistics. Maybe some of the companies have it.

Mr. Richmond: I really do not know. Would you know of that, Mr. Smith?

Mr. Smith: I would guess that 30 per cent of our engineers and scientists are Canadian-born.

Senator Bourget: Are you losing many to the United States?

Mr. Smith: No, talking for United Aircraft we have a sufficiently rapid growth in our activities that we have had relatively small attrition in recent years.

Mr. Richmond: It is a good example; if you can provide interesting work they will remain.

Mr. Smith: We have recruited a large number of people in the United Kingdom, I might say, on a fairly regular basis to fulfil the requirements.

The Chairman: We were told this morning that we are importing people from the U.K. and Europe and that we are exporting to the United States.

Mr. Golden: That did not start yesterday and it will not end tomorrow.

Mr. Taylor: This goes back to the university question. There is much discussion among people these days who are studying exactly what is going on here about so-called mission-oriented research and potentially more mission-oriented research in universities. This is so that those things that the universities are doing will be directly useful upon the graduation of the student. He is then better adapted to immediately fit into the needs of industry. I think we are all hoping that out of the various studies that are going on now we will see more industry, university co-operation and more direction on how the studies should go. In this way when graduates do become available we can immediately fit them into industry without any gaps in what is going on. I think this is a highly desirable direction to reach. Also, if we can establish our national goals as a country and we can orient ourselves, all of us, industry, universities, government laboratories alike, address ourselves to these goals specifically, then we can see a much better overall result coming out of it.

Mr. Ross: If I could add, Mr. Chairman, to what Mr. Taylor has just said. I am quoting numbers here that were given by Dr. Patterson at the Science Council. He estimated that in 1968 there were 5,500 R and D engineers in Canada. He said that it is expected that by 1975 there will be a total of 11,000 such engineers in Canada. The proportion of these engineers with advanced degrees will increase from 30 per cent at present to some 60 per cent in 1975. I think this doubling of the scientific and engineering population means that we have got to double the amount of work that we want to use these people for. If we do not have the economic growth which is going to absorb these people and utilize them effectively, then they are going to leave the country. The money that we have invested in their education will, of course, be lost to the economy.

Senator Bourget: Of course many of them will be absorbed by universities.

Mr. Ross: Some of them will go back into teaching, yes. Some of them are foreign students and they will return to the country of their origin. These numbers, the 5,500 and 11,000 are those that are expected to be available within the country in total. Perhaps what it means is that if universities are planning to produce that number of people there should be a proper relationship between the industry planning and the availability of scientists and engineers.

Senator Bourget: You are not afraid of an overproduction in scientists?

Mr. Ross: The point I am getting to is that maybe there could be an overproduction. I do not know. Unless the rate of economic growth matches the rate of increase in availability of scientists there may be an imbalance.

The Chairman: More and newer aircraft. Have you any additional comments before we adjourn? Thank you very much, gentlemen, for having been with us this afternoon.

The committee adjourned.

APPENDIX 174

BRIEF

TO

THE SENATE COMMITTEE ON SCIENCE POLICY

by

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of

THE BOBTEX CORPORATION LTD.

31 JANUARY 1969

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This BRIEF is in response to the public invitation of Dec. 17, 1968 by The Senate Committee on Science Policy relating to their Study of SCIENCE POLICY IN CANADA.

It is NOT FOR PUBLICATION, except by The Senate Committee, should the committee deem it advisable to make the brief's contents public.

It has been submitted as requested to:

Patric J. Savoie, Secretary
Special Committee on Science Policy
Room 369-E
The Senate, Ottawa

SUMMARY

1. Like capital, inventors and inventions are international in nature, moving to whatever climate will permit them best to prosper.

2. The world is witnessing a technical explosion, two manifestations of which are a battle for technical supremacy and a battle for trade supremacy. In both, technical superiority is the major weapon.

3. Industry nurtured by technical innovation and invention can successfully compete in international markets, in addition to fulfilling domestic needs, and so become export-oriented, to the great prosperity of the host country.

4. Canada with its two strengths of vast and growing primary industries based on unlimited natural resources on the one hand, and being one of the few remaining oases providing a sound basis for long-range investment in a world of economic instability and political unrest on the other hand, could become one of the most preferred locations for the setting up of numerous multinational innovation industries - provided a suitable climate is created through adequate incentives. Under present conditions we are losing out to other countries with a growing technical superiority over us.

5. It is of the utmost importance to Canada that the widening technological gap between our country and the agressive leaders in world trade be reversed. Present Research and Development (R. & D.) incentive and assistance programs, while a step in the right direction, are not effective in creating the proper climate for inventors to

prosper and to bring new inventions and innovations to commercial fruition.

6. Our brief contends that although late in the day, Canada can still acquire the technical competence required to create and support a healthy and expanding secondary industry based on innovation and the need to export dynamically, through implementation of the following two-part incentive program:

(a) a Federal Government-sponsored insurance plan to enable coverage of 75% to 85% of the inherent risk involved in the "idea to hardware" development phase of all inventions whose merits have been evaluated under the scheme as being worthy and capable of commercialization to help foster our national industrial and trade objectives as summarized herein.

(b) a specific income-tax credit plan, including a reinvestment in Canada provision, for industries manufacturing new products based on new technology, and primarily, or exclusively, export-oriented.

INTRODUCTION

7. Much has been heard on the subject of science in Canada and the need for innovation, from government leaders, economists, journalists, and representatives of big industry and of universities. On the other hand, very little has been heard to date from inventors and other innovators, who are often in the best position to judge the requirements of government policies in this area and the effectiveness of any measures designed to stimulate applied science.

8. This brief has been prepared by two inventors with a background of extensive experience in large-scale international

invention industry. It presents measures for the encouragement of Canadian invention and industry based thereon, which, if implemented, would reverse the widening "technology gap" in our vital secondary industry, a situation recognized as dangerous to the Canadian economy; and would enable Canade to participate agressively and successfully in the world's technological explosion.

PREMISES

9. It is essential to recognize the premises and objectives underlying our proposals which follow. The first two are fundamental truths about inventors and inventions. The remaining seven outline Canada's present strengths and weaknesses in reference to the need for our country to fundamentally improve its technological progress.

10. The premises are:

1) The world supply of creative and inventive minds is limited; possessed by few, it is a rare gift of nature. Technical innovation orbits around this inventive nucleus. No amount of money spent on Research and Development can create inventive minds. It is a recognized fact, however, that the most potent stimulants for such, often dormant, inventive minds to become creative are "need" and "reward", the latter in the form of material benefits and social recognition of achievement, primarily both.

2) Inventions, the products of inventive minds, like capital, are highly mobile and international in that technical progress respects no boundaries. They are attracted to where the highest rewards and best scientific environment and economic climates prevail. During the "idea to hardware" stage the availability of adequate

financial assistance offered on realistic and flexible terms for R. & D. work is of paramount importance. In the commercialization phase, tax incentives and easy access to venture capital are imperative. Most countries that have become leaders in the world's technological progress provide many such INCENTIVE PROGRAMS which have succeeded in attracting creative minds and invention industries from all over the world, to the benefit of their respective economies.

3) Canada enjoys an undisputed advantage and attraction for continued growth in its resource-based primary industry. Our enormous natural resources, both already known and as yet undiscovered, and a gradually expanding home market, constitute a great economic potential for investment and reinvestment of money earned for many generations to come. Large though our primary industry is, however, it is growing less fast than secondary industry, and has progressively declined to 10% of. Gross Domestic Product (G.D.P.)in 1967.

4) Canada's secondary manufacturing industry, on the other hand - now accounting for about 25.1% of G.D.P. (1967) - is now highly vulnerable due to diminishing trade barriers (Kennedy Round) and inadequate technological progress; it is recognized that international trade is increasingly stimulated by technical superiority and to a lesser degree by a contest of prices.

5) Unfortunately, Canada does not yet provide adequate R. & D. and realistically oriented incentive programs. Creative minds from outside are not being widely attracted, the drain on our <u>best</u> brains has not been arrested, and increasing foreign ownership has not been checked. While the first two are contributing factors

to the latter, the effect is compounded by the well-documented subsidiary company characteristics prevalent in a large portion of Canada's industry. In the case of the brain drain, it is not the sheer numbers lost but the high quality of the exodus which hurts most.

6) The limited size of the Canadian market is a serious handicap in attracting new invention industries. Even in the case of Canadian inventions, under present conditions it would be against fundamental economic laws to chose Canada as the world base for such new industries, which are multinational by nature. This will remain true until Canada adapts and extends its current assistance programs and provides more effective incentives which could more than offset present handicaps and thus justify new industries setting up here.

7) In many fields Canada is a latecomer in joining the world-wide battle for technological supremacy. As such, in order to improve its chances of being successful, it must not only match but even excel in any incentive weapons it utilizes as compared to its competitors.

8) From the most fundamental point-of-view, Canada's most urgent need is an OFFENSIVE entrepreneurial new secondary industry based on new ideas, new inventions and novel technology effectively applied to the manufacture of new products and to a more agressive expansion of Canadian exports into world-wide markets. In contrast to this, DEFENSIVE innovations geared to improve old technologies of existing industries provide smaller advantages; moreover, they are inherently more vulnerable in this world of rapid technological change.

9) Given proper incentives, Canada can well become one of the most preferred locations for the setting-up of many multinational innovation industries, for the following reasons:

a) Canada is located at the doorstep of the world's largest consumer and capital market and at major crossroads of international East - West - South trade.

b) In a world of economic instability and political unrest, Canada is one of the few oases left which still provide a sound climate for long range investment.

c) The existence of abundant domestic natural resources referred to under item 3 above.

11. All this constitutes opportunities of great magnitude for Canada. If we are successful in attracting such innovation industries, it will enable us to mold to our own design an even greater future. This can only be done by creating an appropriately attractive climate in Canada.

12. Canada has nothing to lose but a great deal to gain by introducing special incentive programs to attract such new-invention industries, primarily and often exclusively export-oriented, producing new products and using new technology, not yet applied in Canada. On the other hand, without such programs, the enormous additional benefits which are possible to be gained for the Canadian economy of the future will be sacrificed.

OBJECTIVES

13. The above premises clearly infer two major objectives for the Canadian Government:

a) To provide adequate and flexible ways and means for effective assistance to inventors to enable R. & D. financing of inventions from the idea through to the hardware phase of development.

b) To provide more attractive and effective incentives to new-invention industries to stimulate their setting up of operations here, and to ensure reinvestment of part of their profits in Canada to enhance perpetual industrial growth and innovation.

PROPOSALS

I. Government-Sponsored Invention Risk Insurance

14. More often than not, inventors/innovators do not have adequate funds to embark on the long and costly road of R. & D. work to bring their invention from the idea to the hardware stage. At this initial and most crucial stage they will seldom qualify for any of the present R. & D. assistance programs within the Program for the Advancement of Industrial Technology (P.A.I.T.) or the National Research Council's (N.R.C.) Industrial Research Assistance (I.R.A.) which at best provide 50% of the costs involved. Many an invention has been abandoned or lost to mankind and to the Country of origin because the inventor failed to find the needed venture capital, willing to take a gamble with respect to the inherent risk involved in even the most promising inventions at their initial R. & D. stage. Independent inventors often do not even have adequate funds to secure proper patent coverage.

15. With some exceptions, to a significant degree large corporations have lost the risk-taking pioneering spirit which made America great. Now, many prefer to jump on the band wagon after the inventions have been developed and fully proven, even if this is always much more expensive and often too late. Well-known are such famous ideas as XEROX, POLAROID and many

others which failed to find backers at the early stage who were willing to take the risks involved. In these cases, many industrial giants who had the opportunity to assist and did not, badly missed the boat. By contrast, the Pittsburg Mellons' pioneering spirit laid the foundation to their industrial empire, including aluminum and carborundum, by practical implementation in the past of their motto: "Give us an inventor with a good idea but no money, and we shall provide the money and jointly exploit the idea."

16. A strong parallel can be drawn between the problems of exports and those of the invention industries. The invention industry, which is the mother of major exports, presently finds itself in Canada with the same financing problems as have beset and seriously handicapped product exports. The latter involve inherent and unavoidable export risks as well as financing demands because of deferred payment terms after the goods had been shipped. Country after country was thus forced to provide the exporter with up to 85% of the export value with a Government guaranteed export credit-risk insurance against payment of a reasonable premium. Canada's own Export Credits Insurance Corporation (E.C.I.C.) was initiated in 1945. On the basis of this insurance, exporters are now able to finance export transactions in private capital markets, primarily banks of their choice, because the export risk factor has been substantially eliminated. The result: exports, such as Canadian wheat for instance, started to move at an accelerated pace and apparently the overall losses to the Canadian Government are much below the insurance premiums collected, in spite of the often high financial and political risks involved.

17. A similar risk insurance plan could well be applied to enable coverage preferably of 85%, but not less than 75%, of

amounts advanced to an inventor by any financial source, preferably also including banks, the remaining 15 or 25% being absorbed by venture capital financing, which would thus be easier to acquire. Such financing would be confined to applied R. & D. work on specific patented or patents-pending inventions, covered by said Government risk insurance after proper educated evaluation of their merits, to carry the invention from the idea through to the commercialization stage. The risk insurance coverage involved would be limited to a total amount and term agreed to in advance in each individual case. The insurance premiums could be made payable by the financing medium on each amount advanced to the inventor. It could be extended into the commercialization stage by premium payments on the value of sales materialized from the respective invention until the total amount of premiums paid reaches the total amount of the insurance coverage. The aggregate insurance premiums collected should substantially exceed any losses incurred and provide a sound basis for perpetual extension of the scope of this insurance plan. For all practical purposes it would de facto constitute a backwards integration of the present product export insurance into the export product development and manufacturing phase, the primary source of all industrial exports.

18. In the broad context, the principle of credit insurance related to technically oriented secondary industry should be looked at in the light of the long term financial requirements of a dynamic and efficient science policy for Canada.

19. It is almost certain that the most effective step that could be taken in the area of innovative secondary industry financing in Canada at this time would be the further

development of the concept of industrial credit insurance. Thus, moneys could flow into small secondary industry not on the basis of the credit of the borrower, but on the credit of the insurer which would be unassailable.

20. Small business lending is usually considered risk lending, which is a bad concept. The effect is undesirable because the lender thinks or claims that the risk can be compensated by an increase in the rate of interest which is self-defeating as it increases the burden of fixed interest payments to the borrower. The business of insurance on the other hand is directly related to risk taking and the insurer has to accept the fact that he is being paid through premiums to accept risks.

21. For any private institution involved in direct lending activities, the effect of a loan going sour can be bad not only for the credit of the lender, but also in the inhibiting effect it has on future lending. On the other hand, a credit insurance company would not be performing its function properly if, over a period, it did not have to stand some underwriting losses; its reserve mechanisms are designed for this purpose.

22. As in any insurance activities the underwriting of risk would be the key, but as a practical matter there seems to be no reason why the talent of existing institutions whether government or private, could not be utilized for this purpose.

23. Industrial credit insurance would compete with nobody; it would harness and supplement the activities of the present institutions active in venture capital financing and would open the door to supplies of moneys from say pension funds and trust funds which are at present unavailable for this purpose.

It would enable a great central promotional effort to be made goading on business without treading on any toes, while the actions of the authorities would have a very much greater impact on the economy than could be achieved by additional direct lending through existing or new agencies.

24. To encompass these aims, it is natural to wonder whether the research, talent and experience presently available in the Industrial Development Bank could not be specifically channelled into this area of credit insurance. One of its main functions would be the underwriting of industrial credit risks and it could also offer certain services in the area of managerial assistance.

25. Its primary relationship would be with a limited number of approved lenders who could demonstrate certain specialized expertise and through whom insured loans would be made to developing corporations. Some of these approved lenders would be existing institutions with experience in this area.

26. Such a flexible program would be very attractive to inventors and industrialists of many countries in the world, including Canada. It would greatly enhance their interest in persuing their activities here, and at the same time they would be attracted to a lesser degree to go south of the border with the development and commercialization of their ideas.

27. Dilution of the risk factor (inherent in new idea development and implementation) among numerous parties involved would result. More importantly, the Canadian Government would not need to provide any allocations of funds in its budget for this purpose, assuming that on the average the losses should be well below the amount of insurance premiums collected.

28. The scope of such assistance would thus be considerably increased and widened. The invention risk insurance possibilities would no doubt enhance the importance as well as the effectiveness of all hitherto existing R. & D. assistance programs, such as Industrial Research and Development Incentive Act (I.R.D.I.A.), P.A.I.T. as well as N.R.C.'s I.R.A. Inventors would thus be able to operate within highly flexible assistance programs aimed at mission-oriented projects together with Canada's Universities, (already increasingly involved in cooperation with private industry) resulting in a better scientific environment.

II. Special Income-Tax Incentives for Export-Oriented New-Invention Industries.

29. To attract companies desirous of setting-up plants to exploit new processes or products, not being exploited in Canada, long range income-tax-credit incentives should be provided for a period of about ten years. By their very nature, such new products and processes based on technical advancements and innovation are multinational in character and in their commercialization. Multinational industrial corporations have to operate on the basis of long-range planning and thus would be reluctant to consider acceptable the present 3-year incentive programs. Nor would they agree to confinement to designated areas: the choice of location for setting up of such modern plants is governed by prevailing conditions most favourable from the economic, social and scientific points of view, and depends on the raw materials used, the type of product manufactured, markets to be served, the scientific-technological environment needed and labor sources available.

30. To prevent conflict with General Agreement on Tariffs and Trade (G.A.T.T.) provisions and to assure continuous growth of the Canadian economy, it is suggested that the income-tax-credit incentive should stipulate that the full prevailing

corporate income tax is payable every year into a special account of a Canadian bank of the respective company, with the provision that the company have unrestricted drawing rights from this account; however, only for the purpose of reinvestment in Canada for future defined expansion and innovation needs (such as plant and equipment), without any repayment obligations ever. Any amounts not withdrawn for this purpose within three years from the date of its deposit on this account would have to be transferred to the Government Income Tax Office. Such a tax-credit incentive scheme would not interfere with the restrictive provisions of G.A.T.T. - which consider export subsidies as an indirect devaluation - because de facto it would constitute an internal industrial growth and innovation stimulant, in contrast to the "added value" and other direct or indirect export subsidies used by many countries.

31. In a world of rapidly and continuously changing technologies and the consequent high risk factor involved, the return of capital invested must be accordingly accelerated in order to finance perpetual innovation and fast expansion to stay abreast of technological progress and competition. Therefore, full advantage should be taken of the initially high demand for new products, as it may well level off after a short time. From this stems the direct need for incentives in the form of income tax credits as outlined above.

32. If Canada wants to profit from the world's technological explosion to a larger degree than it has up to now, it must be progressive in its thinking; act agressively; and be timely in accord with the prevailing world trend.

33. Approval in principle of the two recommendations in this brief is sought from Ottawa at the present time.

34. As the recommendations go beyond the confines of what could be referred to as Science Policy and have a bearing on foreign affairs, Canadian and International trade, commerce, finance, taxes and tariff relations, it is recognized that immediate implementation may offer some difficulties.. Nevertheless time has become an important factor; implementation of the Kennedy Round provisions entails the currently pending international negotiations. For the practicalities of setting up of multinational industries, any new incentive programs in Canada preferably should precede conclusion of these talks.

35. The authors are very encouraged by the Canadian Government's appeal to Canadians for their direct involvement in the economic affairs of the country and are appreciative of the opportunity to present this brief. It is our firm belief that a far-sighted expansion of the present Government Policy on Science can help Canada to advance its level of technological achievement to that which is needed for successful economic growth and expansion. We are willing to present our more specific viewpoints at any public hearing of the Senate Committee on Science Policy, if and when so desired.

36. Respectfully submitted this thirty-first day of January, the year one thousand, nine hundred and sixty-nine.

Emilian Bobkowicz

Dr. Andrew J. Bobkowicz

NOTES ON THE AUTHORS AND ON BOBTEX CORPORATION LTD.

37. The authors are respectively President, and Vice-President: Research and Development of The Bobtex Corporation Limited, described briefly hereunder. Their Curriculum Vitae are included as appendices A and B.

38. A co-author of this brief is Mr. Michael Boyd.

39. The Bobtex Corporation Ltd. is a company incorporated under the laws of Canada having its head office in Montreal. It is a technological company, comprised of engineers and scientists striving to bring to commercial fruition a new and revolutionary textile process based on world wide patents held by Mr. E. Bobkowicz and Dr. A. J. Bobkowicz, the founders of Bobtex. The inventors hold 245 Canadian and world wide patents, 146 granted and 99 pending, in 29 countries. Participating co-founders of The Bobtex Corporation are the Aluminum Company of Canada, Ltd. and the firm of Boyd, Stott, McDonald and Phillips Ltd., as is reflected in the composition of the Board of Directors of Bobtex:

Mr. Emilian Bobkowicz, President and Chairman

Dr. Andrew J. Bobkowicz, Vice President
(Research and Development)
and Treasurer

Mr. Paul H. Leman, Executive Vice-President
Aluminum Company of Canada, Ltd.

Mr. R. T. Hyland, Vice President
Alcan International Ltd.

Mr. Michael Boyd, Director of Fry & Company Ltd.

40. Financial support and technical assistance is being received by Bobtex from the Aluminum Company of Canada, Ltd. and from the Polymer Corporation in Sarnia. The extensive Bobtex R. & D. activities are also receiving considerable support from the National Research Council within their I.R.A. Program.

APPENDIX 175

A BRIEF BY THE

AIR INDUSTRIES ASSOCIATION OF CANADA

TO THE

SENATE SPECIAL COMMITTEE ON SCIENCE POLICY

March, 1969

INTRODUCTION

The Air Industries Association of Canada is very pleased to respond to the request of the Senate Special Committee on Science Policy for an aerospace industry statement on this important subject.

Over the past few years an increasing awareness has developed as to the need to study and forecast Canada's future in respect to its economic, technological and industrial facets. The Economic Council and the Science Council have issued a series of reports which bear on these subjects. These reports have been based on a number of studies, reports and presentations, some of which have been specifically commissioned and others prepared voluntarily by interested parties. Of particular interest to the aerospace industry is the report being prepared by the Aerospace Marine and Rail Branch of the Department of Industry, Trade and Commerce. The first two volumes of this report which contain substantial quantitative data have been published and the third volume, which we understand is directed at developing recommendations as to future policy for the industry, is in course of preparation.

All the reports and studies illustrate clearly that Canada's future economic welfare is inextricably linked to its industrial growth. They also note that the speed of industrial growth of the most advanced countries is closely relatable to their level of technological competence. In most instances the aerospace industry is highlighted as a prime contributor to Canada's technological competence.

There would appear therefore, to be little argument today as to the advantages to be gained by Canada in maintaining a high level of technological capability. The problem is to establish directions of effort which will be most effective in achieving Canada's overall national goals of growth and improved social conditions.

2. BACKGROUND

The environment in which the Canadian aerospace industry exists is conditioned by the limitations of Canada's domestic and military aerospace requirements. The steady growth of the industry within this environment is due to its ability to compete in the international market. In 1967 and 1968 some 60% of the total industry production was exported. This is the highest percentage export of any aerospace industry in any country in the world and this industry is now Canada's third largest manufacturing exporter.

The domestic base although relatively small is significant and, in addition, it provides a proving ground for specialized equipment which is subsequently sold in the international market place.

The output of the industry is increasingly commercially oriented.

In 1968 the aerospace industry employment was approximately 50,000 with some 2,500 being engineers and scientists. It is clear that this technologically advanced industry plays a very important role in attracting and retaining high quality technical people for Canada.

The activities of the industry now encompass a broad spectrum which in addition to aircraft and aircraft engines include avionics, flight simulators, space products, accessories and ground support equipment. The avionics segement alone has now achieved 1/3 of the total annual sales of the aerospace industry and Canadian electronic and avionic products enjoy an international reputation for technical excellence in many specialized areas.

The development of most of the aerospace products which have generated current industry sales was commenced several years ago. New products that will be offered in future years and the acceptance of these products by both domestic and export markets will be determined by the research and development effort which goes into the Industry now.

THE NEED FOR INCREASED R & D SUPPORT

The aerospace industry is already a leader in demonstrating the effectiveness of concentrated, product oriented technological development. The industry is prepared to augment present efforts substantially but to do so, increased direct government funding is required. Other more general forms of support provide stimulation, but increased direct funding of research and development is essential. The Air Industries Association of Canada requests that serious consideration oe given to expanding current Government R & D assistance programs by increasing the level of financial support for projects that lead to the development of internationally competitive products. In support of this straight-forward request the following comments are provided:

(a) Previous briefs presented to the Special Committee of the Senate On Science Policy have noted that the Canadian Government R & D expenditures as a percentage of G.N.P. was low compared to other Western Countries. Of even greater consequence is the small proportion of these expenditures that is available to industry. The Fifth Annual Review of the Economic Council of Canada quotes that of the $351,000,000 in Government R & D. expenditures, 69% spent in government research laboratories, 16.5% in universities and only 14.5% in industry. The industrial percentage in Canada is strikingly lower than other industrialized countries; for example in the United States about 65% of every research tax dollar is spent in industry.

In view of the facts that development and product design with ensuing production bring the most immediate benefits to the economy and that, to be effective, these phases must be conducted by industry, the Association believes that the total funding available for R & D should be increased substantially and that the bulk of this increase should be assigned to industry.

(b) The various government assistance programs have unquestionably been beneficial in promoting the R & D in the aerospace industry which has led to production and sales. However, these programs call for substantial cost-sharing with the government. Hence, the aerospace industry, in endeavouring to respond to growth opportunities, is currently generally investing almost all of its available funds in the innovation of products and services. Further acceleration in expansion rate requires increased R & D assistance.

(c) The principle is accepted that industry should participate in funding the research and development phase to ensure responsible product selection. It should be noted however, that the further costs of tooling, of prototypes, of production start-up and of market development, which are incurred in bringing a new product into successful production, are also very large. These costs also ensure the careful selection of products and in addition they represent a significant further financial burden.

In light of the foregoing the Association suggests that, as an alternative to substantially increased R & D support, consideration might be given to government sharing of the total non-recurring costs of bringing a specific new product to the market place.

(d) The terms covering some of the cost-sharing R & D programs administered by the government include a requirement for repayment to the Crown for financially successful programs. The Association believes that there should be a reassessment of the repayment requirement for research and development assistance funds. As noted above, research and development is only a portion of the costs associated with the innovation process in high technology industries. Hence, industry should assign available funds to any other unsupported costs incurred and to its share of further research and development rather than to repayment of past research and development assistance. The government will recover its investment from the increased

corporation and private income taxes generated by successful programs. In this regard the Association would draw attention to the views of Professor V.W. Bladen in his appearance before the Senate Committee.

(e) The investments prior to payoff on aeronautical products are very large but the business and therefore the employment resulting from a successful product is large and enduring; for example a successful airplane or airplane engine stays in production for 10 to 20 years while a successful avionics product has a production life of 5 to 15 years. The very large early investments and the long payoff make increased direct assistance in the launching phase essential.

4. SUMMARY

To summarize, the aerospace industry is currently a pace setting industry in terms of successful exploitation of innovative technology. Its export record is outstanding and the R & D capability in the industry exists, it does not have to be created, it is today an effective, mobilized technical force. The industry is product oriented and is capable of immediate expansion. Existing government assistance programs have been effective but to accelerate growth and to continue to compete successfully in export markets, which it must do to stay viable, the aerospace industry must have increased direct R & D assistance from government.

The Association hopes that the views expressed herein will be of assistance to the Special Committee on Science Policy and that the endeavours of that Committee will lead to an increased awareness of the importance of industrial research and development in achieving national goals of economic growth and improved social conditions.

APPENDIX 176

Brief of United Aircraft of Canada Limited
to
the Senate Special Committee on Science Policy

12 MAY 1969

There is much discussion in Canada on Science Policy at the present time, so much so that I will not recite again the reasons for all these reviews. These are well known to this committee. Rather, I would like to make some specific comments on the operations of United Aircraft of Canada Limited.

The Company has a number of activities, which are described in general terms in a series of Appendices to this brief. I will discuss in the following our PT6 gas turbine engine program only, to illustrate how judicious Government support for development projects can produce worthwhile results.

By the end of 1968, the Government had contributed $12.6 million to this program, the full amount pledged by the Government being $15.8 million. The combined investment of the Government and the Company has produced the following cumulative employment, product and exchange volumes, expressed in millions of dollars:

Year	Cumulative Government Support	Cumulative Gross Payroll			Cumulative Total Sales	Cumulative U.S. Currency Sales *	Cumulative Net U.S. Currency Inflow *	Cumulative Canadian Content **
		Engrg.	Other	Total				
1962	3.5	7.2	0.8	8.0	-	-	-	-
1963	4.2	9.4	1.5	10.9	-	-	-	-
1964	5.6	11.9	4.1	16.0	2.6	2.5	1.6	1.7
1965	7.8	14.1	8.4	22.5	10.1	9.1	5.7	6.7
1966	10.9	17.1	14.6	31.7	27.1	23.2	14.3	18.2
1967	11.9	18.8	22.4	41.2	58.9	48.0	29.0	39.9
1968	12.6	20.3	30.9	51.2	92.0	71.3	42.1	62.8
1969	13.4	21.8	41.9	63.7	136.0	102.3	60.9	94.6
1970	13.9	23.1	54.5	77.6	188.0	142.3	87.9	133.6

* These are direct exports only. They do not include sales to Canadian customers for installation in aircraft to be exported.

** Recurring production content only. Excludes design, development and non-recurring production costs.

While forecasts beyond 1970 exist, data beyond that point have not been used lest they detract from the validity of the figures. This table indicates that a relatively small investment on the part of the Government to enable the Company to proceed with a program in time to meet market requirements has fostered a contribution to our country's GNP and foreign exchange out of all proportion to the amount invested. By the end of 1970, a $13.9 million investment of Government funds will have fostered $133.6 million additional GNP with increasing annual increments ($22.9 mn, $31.8 mn and $39.0 mn in 1968, 1969 and 1970), such that the addition to GNP in 1970 alone will be three times the cumulative gross Government investment.

The investment has also helped to develop a capability which has made it possible for Canada to take advantage of further opportunities to increase the GNP through additional products in the small gas turbine engine category, where Canada has developed a fairly unique prowess.

I hope the example of the PT6 will serve to illustrate that:

(1) Effective exploitation of development projects is best undertaken by industry.

(2) Government support to development can result in very beneficial effects on employment, our balance of payments, and our technological capabilities.

In closing, I should mention that we have a continuing program of applied research in collaboration with the Defence Research Board. This has been an effective program, results of which have been embodied in development projects such as the PT6.

TE Stephenson

T. E. Stephenson,
President.

jsc
att.
29 April, 1969

APPENDIX A

A SHORT COMPANY HISTORY

United Aircraft of Canada Limited (UACL) was created as a sales, service and overhaul organization in 1928 to handle the products of Pratt & Whitney Aircraft, a division of United Aircraft Corporation of East Hartford, Connecticut. *

During World War II, UACL branched into manufacturing when it produced Hamilton Standard constant speed propellers and Pratt & Whitney Wasp engines. The Company now manufactures in Montreal, for worldwide markets, all Pratt & Whitney piston engines and spare parts.

In 1958, the Company created the nucleus of a design and development organization. After orientation at Pratt & Whitney Aircraft of East Hartford, and the completion of preliminary design of the 3,000 lb. thrust JT12 gas turbine engine, this team designed its first Canadian aero engine, the PT6 gas turbine. The first production engine of this program was delivered in 1963 and at this date over 2900 engines have been delivered to customers. Current manufacturing plans call for a substantial level of production of this engine over the next ten years. Based on the market acceptance of the PT6 engine, UACL has embarked on a new engine project, an advanced turbo-fan or fan-jet engine, which will go into production for the General Aviation market in 1971 and for which orders have been won from two major manufacturers in the U.S.A. and France.

In 1962, UACL entered into the helicopter field. The Company is currently involved in detail design and manufacture of components for the Sikorsky CH-53 primarily for the U.S. market.

In 1966, the Company formed an Industrial and Marine Division to handle all projects not connected with the aircraft industry. PT6 engines are now being used in Turbo-Trains in the U.S. and Canada, wood chippers in the pulp and paper industry, sea-going boats and hovercraft, fracturing units in the oil industry, power generation and gas pumping systems, high speed snow plows and in highway trucks.

United Aircraft of Canada Limited currently employs more than 5,000 people in the Montreal area in seven plants occupying over 1-1/2 million square feet of area. Over 900 members of our technical staff are employed in engineering and management tasks.

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* The following are divisions of United Aircraft Corporation, East Hartford: Pratt & Whitney Aircraft, Hamilton Standard, Sikorsky Aircraft, Norden, Electronic Components, United Technology Center and Research Laboratories.

APPENDIX B

UACL'S BUSINESS ENVIRONMENT

United Aircraft of Canada Limited develops, manufactures, markets and supports in the field a proprietary line of products that is complementary to that of United Aircraft Corporation (UAC) of East Hartford. More precisely, UACL produces small gas turbine engines aimed at the General Aviation market. UAC, on the other hand, produces large gas turbines that power over 70% of the aircraft operated by the major airlines of the world.

From the time of the Korean War, UAC has given UACL rights to produce under license spare parts for all existing Pratt & Whitney piston engines and to support their operators around the world. This business has provided the production base and the profits for the development of a Canadian line of gas turbine engines. UAC sponsorship in the activity has ensured UACL access to the U.S. market and in particular to the U.S. Military market. In transferring this piston engine business to UACL, UAC has made a long range investment in Canada while concentrating on its large gas turbine engine business in East Hartford.

UACL has received financial aid from the Federal Government for the PT6 and JT15D engine programs. As a direct result of this support on the PT6 engine program it is estimated that in 1983, or 20 years after the start of production, the cumulative sales on this program will be over $1.6 billion with 90% of our production being exported to the U.S. We estimate sales of over $2-1/4 billion over the life of the program. We anticipate the JT15D engine program sales to be in excess of those of the PT6.

Sales in the U.S. will continue to be possible because of the excellence of our specialized products and their competitive prices and because of UAC's sponsorship, particularly in the U.S. Military market.

Successful Canadian aircraft products such as the PT6 engine which is in operation around the world, have helped to establish Canada in the international market place for quality goods and have paved the way for other exports. Canada's place in the market is doubly reinforced when Canadian engines are selected for U.S.-manufactured aircraft in use around the world.

APPENDIX C

UACL'S MARKET

The following table presents the forecast activity mix at UACL as exemplified by sales:

UACL SALES BY ACTIVITY

	1968 Actual %	1973 Forecast %	1978 Forecast %
Proprietary Products	23.6	59.7	62.4
Licensee Products	43.8	10.6	3.1
Overhaul Activity	8.4	5.5	6.9
Industrial & Marine Products	9.7	15.2	20.9
Helicopter & Systems Products	4.3	3.7	2.3
Agency Products	10.2	5.3	4.4
TOTAL	100.0	100.0	100.0

As indicated in the preceding table, nearly 2/3 of our forecast sales in 1978 will be generated by our proprietary line of products tailored to the General Aviation market. The users of our products are:

(i) commuter airlines - transportation of commercial passengers and freight,

(ii) business corporations and government agencies - executive transportation and utility applications,

(iii) air taxi operators - charter service, and

(iv) flying schools - training of professional and private pilots.

This market is forecast to grow rapidly as indicated in the following table: *

U.S. GENERAL AVIATION ·
TOTAL AIRCRAFT PRODUCTION

	1967	1975	1980
Unit Production	10,850	17,900	21,560
U.S. $ Production (Millions)	475.3	1,108.5	1,660.6
Increase in $ Production over 1967 - %	100	233	350

One rapidly growing segment of the U.S. General Aviation market served nearly exclusively by UACL's PT6 engine is that for turboprop aircraft. This can be seen from the following table:

U.S. GENERAL AVIATION
TURBOPROP AIRCRAFT PRODUCTION

	1964	1965	1966	1967	1968
Increase in Unit Production over 1964 - %	100	277	444	475	750

This growth trend is forecast to be maintained.

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* This data was obtained from a study recently published by the Utility Aircraft Council of the U.S. Aerospace Industry Association.

The Industrial and Marine market which is forecast to generate 20% of our sales in 1978, is in a developing market; a measure of its growth rate is presented below:

U.S. INDUSTRIAL & MARINE MARKET
1,000 - 6,000 SHP GAS TURBINES

	1965	1967	1972	1977
Increase in Unit Demand. over 1965 - %	100	107	146	180

UACL guarantees customer product support services for the lifetime of an engine. This can exceed 40 years. Currently, UACL provides technical field support, overhaul and parts service to over 520 operators in 47 countries.

APPENDIX D

UACL'S PRODUCT

ENGINE DEVELOPMENT

UACL produces small, lightweight gas turbine engines that are economic and reliable to operate over a wide range of conditions.

In a successful engine program as many as ten different models may be produced in quantity over a 25 year period with the last model having well over twice the power of the first model. This increase in power must be achieved for:

(i) small increases in cost and weight,

(ii) decreases in fuel consumption rate, and

(iii) an ever increasing reliability.

To cope with the demands of the market, a great deal of development effort must be invested over the engine program life, and particularly at the early stages of the program, to:

(i) "build in" a portion of the anticipated growth potential of the engine, and

(ii) ensure low production costs right from the very first engine.

The balance of the development effort must be invested over the life of the entire program for:

(i) the refinement and support of each existing model, and

(ii) the development of each successive engine model.

It is noted that the cumulative non-recurring expenses associated with engineering, design and production start-up at the end of an engine program, can be of the order of six times the cumulative non-recurring costs incurred to the start of production on the first engine model of the line.

TECHNOLOGY TRENDS

In the future, advances in gas turbine engine performance are likely to be achieved through increases in heat addition during combustion (with engine volumes and weights per unit of output power lower than today's engines). Hand-in-hand with this, higher compression pressure

ratios will be required for the maintenance of optimum engine cycle efficiency.

Increases in heat addition imply higher turbine inlet temperatures which require new materials and blade cooling to prevent deterioration of engine component strength.

Higher compression pressures imply greater aerodynamic sophistication and higher engine rotational speeds; these must be achieved with simple designs.

Pollution of the environment due to propeller, fan, combustion, compressor, bearing and jet efflux noise as well as gaseous and particle by-products of combustion, will have to be rigorously controlled at the design stage.

Improvements in manufacturing productivity will be achieved through:

(i) simplicity of design - simpler air flow paths, fewer engine components,

(ii) the use of materials with better machinability and formability - which still satisfy the needs of higher engine performance.

(iii) improvements in manufacturing processes and machines, and

(iv) increased automation in production.

Further automation of the production process is most likely to occur through:

(i) the slaving of large quantities of machine tools and production processes to a master computer with sensible multiplexing for low down-times,

(ii) the integration of inspection routines with machining operations, and

(iii) the use of on-line systems for production management information, collection, synthesis, distribution and analysis with real time diagnostics.

The Queen's Printer, Ottawa, 1969

First Session—Twenty-eighth Parliament
1968-69

THE SENATE OF CANADA

PROCEEDINGS
OF THE
SPECIAL COMMITTEE
ON

SCIENCE POLICY

The Honourable MAURICE LAMONTAGNE, P.C., *Chairman*
The Honourable DONALD CAMERON, *Vice-Chairman*

No. 73

WEDNESDAY, JUNE 25th, 1969

WITNESS:

Quebec-Hydro-Electric Commission: Dr. Lionel Boulet, Director of Research

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APPENDIX:

177—Brief submitted by the Quebec-Hydro-Electric Commission

20670—1

MEMBERS OF THE SPECIAL COMMITTEE
ON
SCIENCE POLICY

The Honourable Maurice Lamontagne, *Chairman*
The Honourable Donald Cameron, *Vice-Chairman*

The Honourable Senators:

Aird
Belisle
Blois
Bourget
Cameron
Carter
Desruisseaux
Giguère
Grosart
Haig
Hays
Kinnear
Lamontagne
Lang
Leonard
McGrand
Nichol
O'Leary (*Carleton*)
Phillips (*Prince*)
Robichaud
Sullivan
Thompson
Yuzyk

Patrick J. Savoie,
Clerk of the Committee.

ORDERS OF REFERENCE

Extract from the Minutes of the Proceedings of the Senate, Tuesday, September 17th, 1968:

"The Honourable Senator Lamontagne, P.C., moved, seconded by the Honourable Senator Benidickson, P.C.:

That a Special Committee of the Senate be appointed to consider and report on the science policy of the Federal Government with the object of appraising its priorities, its budget and its efficiency in the light of the experience of other industrialized countries and of the requirements of the new scientific age and, without restricting the generality of the foregoing, to inquire into and report upon the following:

(*a*) recent trends in research and development expenditure in Canada as compared with those in other industrialized countries;

(*b*) research and development activities carried out by the Federal Government in the fields of physical, life and human sciences;

(*c*) federal assistance to research and development activities carried out by individuals, universities, industry and other groups in the three scientific fields mentioned above; and

(*d*) the broad principles, the long-term financial requirements and the structural organization of a dynamic and efficient science policy for Canada.

That the Committee have power to engage the services of such counsel, staff and technical advisers as may be necessary for the purpose of the inquiry;

That the Committee have power to send for persons, papers and records, to examine witnesses, to report from time to time, to print such papers and evidence from day to day as may be ordered by the Committee, to sit during sittings and adjournments of the Senate, and to adjourn from place to place;

That the papers and evidence received and taken on the subject in the preceding session be referred to the Committee; and

That the Committee be composed of the Honourable Senators Aird, Argue, Bélisle, Bourget, Cameron, Desruisseaux, Grosart, Hays, Kinnear, Lamontagne, Lang, Leonard, MacKenzie, O'Leary (*Carleton*), Phillips (*Prince*), Sullivan, Thompson and Yuzyk.

After debate, and—
The question being put on the motion, it was—
Resolved in the affirmative."

Extract from the Minutes of the Proceedings of the Senate, Thursday, September 19th, 1968:

"With leave of the Senate,

The Honourable Senator Lamontagne, P.C., moved, seconded by the Honourable Senator Benidickson, P.C.:

20670—1½

That the name of the Honourable Senator Robichaud be substituted for that of the Honourable Senator Argue on the list of Senators serving on the Special Committee on Science Policy.

The question being put on the motion, it was—
Resolved in the affirmative."

Extract from the Minutes of the Proceedings of the Senate, Wednesday, February 5th, 1969:

"With leave of the Senate,

The Honourable Senator McDonald moved, seconded by the Honourable Senator Macdonald (*Cape Breton*):

That the names of the Honourable Senators Blois, Carter, Giguère, Haig, McGrand and Nichol be added to the list of Senators serving on the Special Committee on Science Policy.

The question being put on the motion, it was—
Resolved in the affirmative."

ROBERT FORTIER,
Clerk of the Senate.

MINUTES OF PROCEEDINGS

WEDNESDAY, June 25, 1969.

Pursuant to adjournment and notice the Special Committee on Science Policy met this day at 10.00 a.m.

Present: The Honourable Senators Lamontagne (*Chairman*), Blois, Cameron, Haig, Kinnear, Yuzyk—6.

In attendance: Philip J. Pocock, Director of Resarch (*Physical Science*)

The following witnesses were heard:

QUEBEC-HYDRO-ELECTRIC COMMISSION
Dr. Lionel Boulet, Director of Research

(*A curriculum vitae of this witness follows these Minutes*)

The following is printed as an Appendix:

No. 177—Brief submitted by the Quebec-Hydro-Electric Commission

At 12.50 p.m. the Committee adjourned to the call of the Chairman.

ATTEST:

Patrick J. Savoie,
Clerk of the Committee.

CURRICULUM VITAE

Boulet, Lionel: Born July 29, 1919. Position: Director—Research Institute Quebec Hydro. Studies: 1938, Bachelor of Arts (cum laude) from Laval; 1944, Bachelor of Sciences (electrical engineering) Summa cum laude—Laval; 1947, Master of Sciences—Illinois, 1948, Preliminary examinations for Doctor degree —Illinois. Professional Career: 1939, Bureau Boulet et Boulet, C.A., Summer; 1940, Bureau Boulet et Boulet C.A., Summer; 1941, Saguenay Power, Ile Maligne, Summer, Engineering student; 1942, Bureau Boulet et Boulet, C.A.—1 year and three months, Junior accountant; 1943, R.C.A. Victor Company, Summer, Engineering student; 1944, R.C.A. Victor, 16 months Junior engineer; 1945, Laval University, Assistant, 16 months; 1946, University of Illinois, Champaign Research Assistant; 1947, University of Illinois, Champaign Research Associate; 1948, Laval University, Electrical engineering, Assistant professor; 1950, Laval University, Electrical engineering, Agrégé professor; 1953, Laval University, Electrical engineering, Full professor; 1948-50, R.C.A. Victor, Montreal, in charge of a research program; 1950-53, C.A.R.D.E., Research consultant; 1954, Director of the Department and of the research laboratories of the Department of Electrical Engineering of Laval; 1963, Teaching of the mathematics of operational research to professors of Economic Sciences and Commerce; 1964, October 1, Consultant—Quebec Hydro; 1965, October 15, Technical advisor to the General Director—Quebec Hydro; 1967, April 6, Director, Research Institute—Quebec Hydro. Positions: 1943-44, President of the Students of the Faculty of Sciences of Laval University; 1961, Member of the Professional Training Committee of the Corporation of Engineers; 1957-58, President of the Quebec Section of the American Institute of Electrical Engineers; 1963, President of the University Professors Section of the Canadian Electrical Association; 1963, Member of the Radio Sciences Committee of the U.R.S.; 1962, Member of the Research Committee of the Engineering Institute; 1967, Chairman of the Research Committee of the Corporation of Engineers. Honorary Awards: 1938, Prince of Wales Award; 1943, Engineering Institute Award, Electricians of the Montreal section; 1943, Corporation of Engineers Award; 1943, Engineering Institute Award; 1947, Member of the Sixma XI Society; 1968, Doctorat Honoris Causa—Sciences—Sir George Williams.

PUBLICATIONS

1. Application des circuits "Lattice" pour produire sur changement de phase de 90° sur une bande de fréquences—Institute of Radio Engineers—1943.
2. Application de l'effet Doppler à la radio-gonométrie (Illinois): No. 1—1947, No. 2—1948 (June), No. 3—1948 (December).
3. Bibliography on hyperfrequencies, September 1950.
4. 1952—Master's thesis of I. Gumowski.
5. 1952—Rear Antenna Radiation Patterns for N-44 Guided Missile Defence Research Board—TNN 84442.
6. 1955—R. F. Energy in Wind Tunnel (in collaboration with Jacques Bonneville) Progress Report 1—CARDE—(1) Bibliography (2) Electrical Source.

7. 1956—Master's thesis of Jacques Rémy.
8. 1957—Master's thesis of Lyall Rowlandson.
9. 1957—Modification of the G.T. 24 as an Exciter for a 100 MCS Signal Source (in collaboration with Jacques Bonneville) Technical Progress Report.
10. 1959—Master's thesis of Pinto Gudes.
11. 1960—Master's thesis of Mohammed Abbas.
12. 1960—Master's thesis of Louis Poujet.
13. 1961—Master's thesis of Kenneth Morgan.
14. 1963—Programme de cours d'un ingénieur-électricien—Engineering Institute of Canada, May 1963.
15. 1964—A.C. Corona in Fourl Weather, Part 1: Above Freezing Point (in collaboration with B. J. Jakubczyk) IEEE Power Apparatus and Systems, May 1964, Vol. 83, No. 5.
16. 1964—Influence of Weather on Corona Losses and Radio Interference (in collaboration with B. J. Jakubczyk) IEEE Power Apparatus and Systems,
17. 1965—Streamers on Power Transmission Lines—Conference Paper 31 C.P. -65-138.

THE SENATE

SPECIAL COMMITTEE ON SCIENCE POLICY

EVIDENCE

Ottawa, Wednesday, June 25, 1969

The Special Senate Committee on Science Policy met this day at 10.00 a.m.

Senator Maurice Lamontagne (*Chairman*) in the Chair.

The Chairman: Honourable senators, we have to start now. Several members of the committee are either busy elsewhere or have had to return to their home base.

This morning we were supposed to receive a representation from the British Columbia Hydro Authority, but apparently their representatives have not been able to make it, so we have only Hydro-Quebec before us this morning.

[*Translation*]

I am indeed pleased to welcome Dr. Lionel Boulet, Director of the Research Institute, who is employed by The Quebec Hydro-Electric Commission. First he will give us his opening statement following which we shall have the usual question period.

[*Text*]

Senator Cameron: Mr. Chairman, I think it would be useful to us, because of the importance of this brief if we could have a brief outline of the witness's background.

The Chairman: Yes. Alors, pouvez-vous donner votre curriculum vitae.

Dr. Lionel Boulet Director of Research, Hydro-Quebec: I am a graduate in electrical engineering from Laval University in Quebec in 1943. I worked for a year and a half with RCA Victor in Montreal as a junior engineer. I came back to Laval as assitant in teaching for a year. I went to Illinois for three years to prepare for my doctor's degree in electrical engineering, and I came back to Laval as assistant professor. I became head of the department. In the meantime I worked for RCA Victor as a consultant and for the Defence Research Board in Quebec as a consultant too. In 1964 the Hydro-Electric Commission asked me to make a study of the possibilities of setting up research facilities, so I got leave of absence from my university and a year later, when Hydro Quebec offered me the post of director of research, I decided to accept it, so since then I am with them.

Senator Cameron: Thank you very much.

[*Translation*]

Dr. Boulet: Mr. Chairman, Members of the Committee... Following your kind invitation to present its brief, the Quebec Hydro-Electric Commission appointed me for the task. We feel that our brief contains not only a summary of the problems which all the Canadian public utilities must resolve now and in the future, but also poses an important question which the public utilities must face,—the increasing demand for electric power. Indeed, it is estimated that by the year 2000, present power production must be increased sixfold.

Since the presentation of our brief, Mr. Gerdes, President of Edison Electric Institute in the United States, an institute which consists of the majority of the American public utilities, made the following statement on June 9, and I quote:

[*Text*]

We start into the future from a high base of achievement. Let us look briefly at that achievement.

At the end of 1968, the total capability of the electric utility industry in the United States was 290 million kilowatts, up 7.8 per cent from the preceding year. In 1969, we foresee a 9.8 per cent increase, bringing the total to 318.3 million kilowatts.

During 1968, the total production of the electric utility industry was 1.327 trillion kilowatt-hours, an increase of 9.3 per cent over 1967. This year the total should reach 1.430 trillion, or about 7.8 per cent over 1968.

Studies by the Institute indicate that we are still in the early stages of a steep upswing

in the use of electric energy. At the opening of the next millenium, just 31 years from now, electric generation should range between 8 and 10 trillion kilowatt-hours annually, which is in fact six times what they have now in the States.

Let me remind you that this prediction is based on an EEI forecast made ten years ago. EEI has not officially changed the forecast range, which shows 6 to 10 trillion kilowatt-hours in the year 2000. However, the annual check of the forecast against actual figures has shown the prediction to be so accurate over the years that our best estimate now is that we will come out between the 8 and 10 trillion marks. The cumulative error in the ten years since 1959 is only two-tenths of one per cent.

The continuing accuracy of this long-range forecast shows the strength of basic trends supporting our industry. For example, use of electric energy is growing at about two and a half times the rate of total energy use and twice the rate of the gross national product. And there has been no slackening in the steadily increasing percentage of the nation's total energy which is being converted to electric power. By 1960, this figure was 20 per cent; by the year 2000 we expect it to be about 50 per cent.

[*Translation*]

Obviously we shall not have the same energy requirements in the year 2000 as the United States, but if we consider population, our predications are identical to those of the Americans. Accordingly, the Quebec Hydro-Electric Commission has undertaken a complete survey of all possible methods of power generation, which we mention in our brief, and of these methods has attempted to analyze those which offered the best results.

For example, we have rejected, as many countries have done at the present time, magnetohydrodynamic methods. We feel that the standard hydraulic or thermal methods will continue to develop, but another source of energy must necessarily be found. Nuclear energy, we believe, is one possibility, provided we develop reactors which we call "breeders" in English and "surrégénérés" in French.

In addition, such developments must take into account another method, thermofusion, if we consider that not only must we increase power production in North America and Europe sixfold, but that there are many underdeveloped countries which also hope to obtain electric power by the year 2000. Thermofusion, while not having harmful radioactive effects, would make it possible to produce a total quantity of energy equal to 10 followed by 120 times the total electric energy produced in 1963.

Obviously, thermofusion is in its initial stages of development. While considerable sums are being devoted to research in thermofusion in countries throughout the world, only very small amounts are being set aside for this purpose in Canada. It is in the initial stages. There are important problems to resolve, problems, I would say, of basic research, but it appears that around 1990 we shall have obtained the first industrial prototype capable of producing electric power.

Obviously, whatever the generating methods, we must also consider the problem of the transmission of this energy. It is presently estimated that, whatever the methods of production, in order to be economically profitable, all these sources must have enormous power, 2,000 megawatts, 2,500 megawatts and perhaps more. Then the energy must be taken from the generating point and transported to the distributing points. This raises the problem of power lines which may have much higher tensions than those we have been using up to now, or power lines using perhaps cryogenic methods. That is, instead of having much higher tensions, special conductors would be placed in the casing and with liquid helium at a temperature very close to 0 degrees absolute and with the conductors losing their resistance, it would likely be possible to construct cables for underground power distribution to large cities or even to transport energy underground from some remote area. These future transmission problems are extremely complex as they pose, first of all, the problem of the space required underground to accommodate the power lines, and, secondly, problems such as effect, current, the space between conductors, protection of animals, etc.

Finally, one of the problems we studied in detail in our brief is the problem of distribution. Obviously, underground distribution is becoming increasingly more common at the present time and, with the means presently at our disposal, the cost is extremely high. Accordingly, we must try to determine new methods, to produce new cables with better insulators, so that underground distribution may be made profitable, or at least less expensive.

With regard to these problems and in making our recommendations to the Committee, we agreed that one of our prime concerns was to avoid duplication with work presently being done in Canada. For this reason, since we already had the Atomic Energy of Canada Limited which studies nuclear problems, we rejected at the outset a similar project for a public utility such as Quebec Hydro. Regarding the supply of power to isolated or remote areas such as the Canadian north, by about 1980 we will have close to 2,000 megawatts of energy source in units varying between 50 and 500 kilowatts. I feel that this is a field which deserves our concentration. We are presently undertaking a complete study of all possible ways of reducing the cost of kilowatt-hours in these remote areas. To give you an example, it costs us, Quebec Hydro, about 19½c. per kilowatt-hour of production to supply power to the remote regions to the north and east of the province and we must sell this energy at 1c. or 1½c. per kilowatt-hour; that means that every time we sell one kilowatt-hour, we lose 17½c. But this gives us the incentive, if you will, for finding other methods which would be much more profitable, such as reactors.

Recently I read a report in the American Public Power Association, a newsletter of April 1969, that the Russians—and I feel it is worth quoting—

[*Text*]

"Indoor garden cities" in the Arctic with heat and power supplied from small nuclear reactors may permit people to live normally through the harsh polar winter, a report from the Soviet Union suggested this month. Russia's official news agency, TASS, said the atomic units designed to operate a 1.5 megawatt turbine, could provide power 60 per cent to 90 per cent more cheaply than standard fuels, and that the plants would operate for three and a half years without refueling.

[*Translation*]

A description follows. It is felt that they will be capable of constructing units of around 150 kilowatts. Obviously, it is not our intention to launch into this field, but I feel that it could be an extremely useful research project which could probably be supported by the Canadian Atomic Energy Board.

Having investigated what was being done about these problems in North America, we were amazed to discover that there was not a single laboratory independent of manufacturers where studies and tests could be conducted along international standards, such as exist in Europe. Apparently, two large European laboratories, that of KEMA in Holland and CESI in Italy, work 24 hours a day almost exclusively for the Americans and Canadians. Naturally, I do not mean to say that the large manufacturing companies of electrical appliances do not have laboratories; I am simply stating that laboratories independent of the manufacturer where tests may be conducted to determine whether given pieces of equipment comply with national or international laws and standards do not exist.

For this reason, even our small appliance manufacturers here in Canada are obliged either to go to Europe or, in certain cases, to another competitive manufacturer in the United States to have tests taken. Accordingly, because such laboratories do not exist in North America, we have suggested to the Commission, which has given its approval, the construction of high tension and high power laboratories. Not only would we be able to study the problems of Quebec Hydro, but laboratories would be created whose characteristics would be international and not just national.

Accordingly, we have hired specialists from the CESI laboratory who have been of immense assistance. We have had special studies undertaken and have determined the dimensions of these high tension and power laboratories. We were also pleased to discover that by using our power network for the high power laboratory, the necessary investments were decreased by approximately 36 million dollars compared to those necessitated if generators driven by a fly-wheel were used, as is the case in the European laboratories. Thus the total investments would be around 35, 36 million dollars. The operating budget would be around 4½ million to 5 million dollars per year. Quebec Hydro has decided to provide annually at least 2 million dollars to support the laboratory. We are now negoiating with the federal government for some form of aid which has yet to be determined.

On the other hand, regardless of the type of laboratory we create, it will not be truly valuable unless the personnel attached to the laboratory is of the highest calibre. I must mention that, up to the present, we have been extremely fortunate in being able to welcome to our laboratory, as director of the high tension laboratory, a Swede who was director of

the high tension laboratory of the ASEA Company in Sweden. In addition, as assistant director of the high power laboratory, we have the former director of the Energy Institute of Prague, Czechoslovakia. We have, in addition, seven English Canadians. We have about a dozen French Canadians. We are presently making offers for two members of the former staff of the English Electric Company in England; since the companies have joined together, there is a surplus of personnel. Finally, we want to contribute towards the creation of an international laboratory.

In conclusion, only two Canadian public utilities, Quebec Hydro and Ontario Hydro, have a sufficiently powerful network to be able to establish high power laboratories like the one we are discussing. Through a unanimous vote by its management, Canadian Electrical Manufacturers Association has supported the establishment of such laboratories as has the Canadian Electric Association. I feel that the establishment of this laboratory will be of great use for Canada. Thank you.

The Chairman: Thank you, Dr. Boulet. Now, the question period.

[*Text*]

Senator Cameron: First of all, Mr. Chairman, may I apologize to Dr. Boulet for not being able to direct questions to him in his own language, for the reason that I have not the facility to do so.

The Chairman: We will have an interface.

Senator Cameron: Yes. However, this is a very important brief in an area that is of vital concern to the country, and I would like to compliment Hydro-Quebec on the magnitude of their concept, and to wish them well.

The brief, on page 4 in the second paragraph, states:

> In the next few years, it will be necessary to undertake construction of an even greater number of power stations, which may be of the conventional thermal type, nuclear or hydraulic.

If the time period is the next few years, then presumably there are now in existence firm proposals. Is that the case? Have you firm proposals in this area?

Dr. Boulet: Yes. You see, right now we are developing—not ourselves, but we are buying the power from Churchill Falls.

Senator Cameron: Yes.

Dr. Boulet: This will take us up to 1976; but in 1971 or 1972 we will have to decide if we are going to build a nuclear station or a thermal station, or go into the hydraulic development on James Bay. This will depend, of course, on the economic study of the complete project, but by 1972, or not later than 1972, we will have to take a decision, because it will take at least two years for the engineering. If you want to start construction in order to be ready by 1977, it takes at least two or three years, or even four years, if you want to build a nuclear station.

The Chairman: That will work.

Senator Cameron: Yes.

> Forecasts indicate that nuclear stations will account for about 50 per cent of the increase in capacity between 1965 and 1980.

Dr. Boulet: Yes.

Senator Cameron: What is the Commission's position regarding nuclear power, especially in view of the statement in the brief on page 1, the second paragraph:

> The Act states that the role of the Commission is to supply electric power to municipalities, industrial or commercial undertakings, and to the citizens of Quebec at the lowest rates consistent with sound financial administration.

Dr. Boulet: Yes. I mean, we have already, as you know, been developing a prototype model of a 250 megawatt nuclear station that is supposed to be commissioned next year, so depending on the results that we get from that station, it might be quite possible, and I know that the Commission is studying now the possibility, to use other nuclear stations near Montreal. However, at the same time we know that all hydraulic development, when it is built, does not cost a cent, or very little, to run. But on the other side, if you go into the James Bay area where we will have close to 9,000 megawatts of hydro power, the distance becomes so long and the cost of your transmission line so high. Just to give you an idea, at the Churchill Falls project, just the cost of the transmission line will run about $500 million from Churchill. Now we found that it will be impossible to use 735 kilo-volts from Montreal to the James Bay area, because of the stability of our network, so we will have to go to higher voltages, 1,200 kilovolts maybe, or 1,300, A.C., or, if that does

not work, we will have to go to D.C. transmission lines. Now, after that, after we decide on the technical angle, we have to make a complete evaluation of the total cost of the project. Of course, if the rate of interest does not go down, maybe at the time the hydro project would be so expensive that we might have to go to thermal or to nuclear.

Senator Cameron: I thought I read some time ago—this is within the last year and a half—that you had developed some new method of high voltage transmission from Churchill Falls.

Dr. Boulet: That is right. This is the 735 kilo-volt line. Our first line was put into operation in 1965 from Manicouagan to Montreal. Now we are extending the network up to Churchill Falls.

Senator Cameron: Yes, but now, because of the distance, it is necessary to develop a line that will take even much higher...

Dr. Boulet: Higher voltage; higher power per line.

Senator Cameron: Yes. What is the stage at which that development is now?

Dr. Boulet: Now the lines are working. The Churchill Falls or the new one? Oh, we are just making a general capability study, and from that, if we find that 1200 kilo-volts will be good, we will go ahead and do some experiments in the labs—at that time the labs will be ready—and find out if it is technically possible to do that; and if it is not, we will have to convert to D.C.

Senator Cameron: I see.

The Chairman: You are just really beginning on this?

Senator Cameron: Yes, that is what I thought.

Dr. Boulet: Yes, because the Churchill Falls project gave us a chance to make all these studies.

Senator Cameron: How long do you think it will take you to discover whether this new experiment will work?

Dr. Boulet: About a year and a half or two years.

Senator Cameron: Have you reasonable confidence that it will work?

Dr. Boulet: Yes, I think from what we have heard from all over the world—from people living in the States and in Europe—they are thinking that the 1200 kilo-volts will work. I do not know if you have heard of the project that was announced at the end of January by a public utility in the States. I cannot remember its name but it has a joint venture with the AEC in order to make that theoretical study and do the experimental work. But now that they know that we will have the technical facilities in Montreal, they will use our facilities to do the experimental work.

Senator Cameron: Would the Commission be prepared to accept tenders for future nuclear power stations from manufacturers outside of Canada, in the event that you go to it?

Dr. Boulet: I think the actual policy of the Commission is to help our Canadian manufacturers in such a way that if a thing is built in the province of Quebec we give them 15 per cent. That is to say, if their bids are 15 per cent higher, we consider them as being equal to the other; if it is in Canada, we give them 10 per cent. So I just do not see how an outside manufacturer could compete, in nuclear plants, with those.

The Chairman: It might contribute to increase the cost to the consumer though.

Dr. Boulet: Yes, of course, but it may be that, by reducing the unemployment, we will get the money back when we sell them electricity.

Senator Cameron: One of the things that intrigues us about this brief is that the proposed research institute is one of national importance and national character. It is proposed by a provincial agency, and you propose that it will be, in effect, a co-operative venture between the provincial government, the federal government, and industry.

Dr. Boulet: Yes.

Senator Cameron: Do you know of a prototype of this kind of research centre anywhere else?

Dr. Boulet: Not in America, but you have the same type in CESI in Italy, where the laboratory is partially owned, in that case, by the ENEL, which is similar to Hydro-Quebec, and by the manufacturers, and they are doing work for outsiders, such as Americans,

Canadians, and so on. So, it is about similar to that, but we do not have such an organization in North America.

Senator Yuzyk: How large an establishment is this Hydro-Quebec's institute of research?

Dr. Boulet: Do you mean as far as personnel is concerned.

Senator Yuzyk: Yes. Could you give us some idea of the personnel involved? Where do you get the personnel? Would you also tell us something about equipment or the facilities that you have?

Dr. Boulet: Yes. The total number of personnel at the start will be approximately 250, with 75 professional people, 100 technicians, and support personnel for the rest of the thing. As I was mentioning in regard to where we got our personnel, because we do not have in Canada, or even in the United States, personnel with experience in that field, we went to Europe. We got people from Sweden, Czechoslovakia, Poland, Germany, England, Italy and Switzerland. Because we are designing that lab to help Canadians, we have at the same time taken young graduates from universities, and sent them with a scholarship to be trained in existing labs in Europe.

Senator Yuzyk: Also in the United States?

Dr. Boulet: We tried, but it is very difficult to send any to the States, because most of the labs belong to manufacturers, and, knowing that we are going to work for other manufacturers in our centre, they do not want our students to have access to all their know-how.

Senator Cameron: There is another point here, and do not misunderstand me in this respect, because I am sympathetic to it. You say that the working language will be French, and I hope to see the day when there is no problem here, but so far have you found much difficulty in getting from other Canadian universities people who were sufficiently fluent to work in French in the labs?

Dr. Boulet: We have hired three, or four people from outside of Quebec. One of them has his doctor's degree from the University of Toronto in electrical engineering. When he came to our place he could not speak a single word of French. In such a case we send him for four months' training in French. He did not speak French when he came to us. But when we say that the working language will be French, we have to remember that if 95 per cent of our customers are English-speaking, we will have to speak English and write reports in English.

Senator Cameron: I am just wondering. I think that of all the university disciplines the engineers are probably the least competent in French in the Canadian non-French universities.

Dr. Boulet: That is right, but I am surprised. Of course, they were in Montreal, but there were two men with doctorates from McGill. One took his doctor's degree in English and he went to work for Westinghouse in Pittsburgh, and he came back with us and in two or three months he was speaking French. We have a man from Sweden who could say yes and no in French when he came to us, but now he speaks French all the time, or English. We do not want any discrimination; but if, for instance, we want to help some English-speaking research people to learn French, we could send them to a French university, but they might not be interested. They might be working in industrial research; if our language is French, it might help them too.

The Chairman: But since you want to establish a kind of national—not only national, but international—institute, which will not be able to ignore, as you say, the United States and other parts of the world, would it not be possible right at the beginning, supposing that this scheme works, to make it officially bilingual, so that you will have the advantages of the two languages instead of only one?

Dr. Boulet: Yes.

Senator Yuzyk: That is an excellent suggestion.

Dr. Boulet: We know that everybody will speak English.

The Chairman: Not necessarily. If they have the advantage of training facilities, they will be able, of course, to write in English, and those who are French-speaking will be able to write in French. So that there will be inter-communication in that way.

Dr. Boulet: In deciding that, we followed the advice of people in research in Ottawa. They told me that you cannot take any official line in respect to having everybody speaking both languages. Take a French Canadian who

wants to work in research for the federal government; not only he has to speak English all the time, but he will have difficulty in having his kids raised in French.

The Chairman: That is not true. I have gone through that experience myself. That is said very often, but I do not think it is true. I have lived most of my time in Ottawa since 1954, and my children have been in French schools.

Dr. Boulet: Yes, in Ottawa I agree with you, but what about Chalk River.

The Chairman: We are taking the Ottawa situation, of course.

Dr. Boulet: Yes, I agree that that is so in Ottawa.

The Chairman: Of course, the situation is far from being ideal at the moment, but we are trying to change this in Ottawa; to make it really possible for French-speaking people to work in their own language, and to leave the same possibility to the English-speaking people. It seems to me that it would not be very desirable objective to start in the other direction in national agencies or national centres in Quebec, while we are trying to improve the situation here. So I think that we will have to move more or less together on this.

Senator Cameron: I think the suggestion that it be a bilingual operation is a good one, but I was just wondering about the mechanics of doing it.

Senator Yuzyk: I am interested in knowing from which universities particularly in Canada, you are drawing your technicians, and also your research experts?

Dr. Boulet: Yes. The experienced ones we had to take from the old countries. We are taking the young men we send for training from McGill up to now, and we have taken one from Toronto. We got some enquiries from Ottawa. As a matter of fact, we are just hiring somebody from Ottawa University. We got three from Saskatchewan. I think Saskatchewan has the best training in this field in Canada. It is run by one of my friends, Professor Nikforuk, and we have hired Chinese from there, a French Canadian who took his PhD. there, and an English-speaking man who is taking his PhD. there. We do not discriminate.

The Chairman: You want to get the best people.

Dr. Boulet: Yes. We do not take them because they are French; we take them because they know something.

Senator Yuzyk: Are you able to get all the people you want?

Dr. Boulet: Not all. In a few fields it is very difficult to get experienced people—for instance, in the mechanical field. We have a very hard problem in the study of the vibrations on our long lines—galloping, and so on and so forth. I have made an offer to the best man in the world, who is Italian, and he could not come because he was happy in Italy. But he did recommend somebody to me from Finland, and now I am discussing the matter with that man. We are trying to pick up the best men. As a matter of fact, we are just in the process, in one of the sections of our laboratories, of hiring a man who is a professor at M.I.T.

Senator Cameron: That is a sound policy.

The Chairman: One of the directors of research here is from M.I.T., so we hear the name of that institution all the time.

Dr. Boulet: Yes.

The Chairman: As if Harvard did not exist!

Senator Yuzyk: How many laboratories have you in operation, and of what type are they, in general?

Dr. Boulet: We will have three laboratories; three buildings. We have a high-power lab, a high-voltage lab, which is a huge building—I think we have given a picture of this at the end of the book—and we have what we call a general laboratory. From all the visits we made in Europe we found that in most of the places where they had testing and research laboratories for high-power and high-voltage, they did not have supporting laboratories containing physicists, chemists, mathematicians and so on, so they had to rely on external consultants to do the work needed—for instance, the choice of materials and so on and so forth. They gave me the idea that if we had these people and integrated them, they would know exactly what are the problems that we have to solve.

On the other side, we could find some work to give them, so that they will not act only as consultants, but do their own research in

their own field. For instance, we have corrosion problems on our lines along the Gaspé, for instance, from salt water action. It needs metallurgists and chemists to solve those problems, or maybe physical chemists. We can put them to work on these problems, to try to find materials that will stand that, so that we do not have transformers falling down every two years.

From the point of view of mathematicians, our network is in a very, very difficult position. It is very, very difficult to solve a mathematical problem, so we will have to make a mathematical model. What we are doing, and what all utilities are doing in Canada, is to go to G.E. in Schenectady, or Westinghouse in Pittsburgh, where they have programs of this sort. So that all utilities in Canada depend in this way on American companies, but these American companies have so much work to do now that we have to wait six months, or even nine or ten months. We think it is about time that we set up our own group that will be able to make a mathematical model of our lines, in order to be able to automatize everything in the future.

Senator Yuzyk: What co-operation do you get from the National Research Council?

Dr. Boulet: Very, very good co-operation. Right now, in the design of what we call our artificial lines, the Research Council has let Dr. Morris, who is the head of that section, come and design the lines for us. He is right now, because he still has some work to do in Ottawa, spending three days in the week at the expense of the National Research Council. We have very good support from them.

The Chairman: Just on that same line, I understand that you have discussed this problem with the atomic energy people?

Dr. Boulet: Yes. They are not in the field, but they are interested in the possibility of the D.C. section.

The Chairman: But part of their research activities would be in those fields too.

Dr. Boulet: Yes. What I was suggesting was that to begin with they could start a study of those small atomic generators that we could put in the north, in the Arctic, as apparently the Russians have succeeded in doing; or get the know-how from the Russians so that they could help us design those small reactors, so that we could use them.

The Chairman: You would certainly have to work in close co-operation with our atomic energy people in order not to duplicate what they are doing.

Dr. Boulet: That is right.

The Chairman: So there would be some kind of agreement on your respective research projects.

Dr. Boulet: Yes. Inasmuch as our field is concerned with generation, we do not have any duplication with what they are doing, but I can foresee in the future that perhaps they would like some utilities to take part of the work that they are doing now, and take, for instance, the fuel of reactors. I just feel that Atomic Energy will get out of that field, and would like to have the utilities take on that part of the work.

Senator Cameron: On page 8, dealing with generation, you have obviously looked into the matter of the ING project, which was a matter of some controversy here, and you have recommended that the federal government consider the following projects: (1) fast breeder reactors; (2) thermofusion, and (3) generation of electricity in remote regions. I presume that you explored with A.E.C.L. the question of the ING generation?

Dr. Boulet: Oh, yes.

Senator Cameron: And your reason for recommending that the project be on the fast breeder reactor was that you did not want to get into the ING project—or did you reject the idea of the ING project?

Dr. Boulet: I have to speak personally?

Senator Cameron: Yes.

Dr. Boulet: I have been connected with the ING project since the beginning. I do not say it is not good research, but I say that we are spending right now so much money in fundamental research in Canada, and so little in applied research and development, that we produce good fundamental research and nobody is using it, and I think it is about time that we go ahead and start some development that will give jobs for people and produce something for the nation. The ING project is a very good thing, but I think it will be—and maybe I am wrong—too expensive if we add that amount to the amount that we are already spending in the field.

Senator Cameron: I understand, from the information we have had here, that the Americans are spending a good deal of money on the fast breeding reactors.

Dr. Boulet: Yes.

Senator Cameron: As another method from the ING project. Do you think we are warranted in getting into that field in Canada when the Americans are doing a lot of this work?

Dr. Boulet: With all the experience that we do have in breeders, I do think, as I have mentioned in my report, that this is so expensive that we should go into an international collaboration. I do not mean that we have to design that thing, but I think we should have a team in Canada which knows everything about breeders so that if they come through we will be able to start to build them. I was listening to a speech by Dr. Seaborg, who is the president of the American Atomic Energy Commission, and he said something that is very interesting.

The Chairman: Are you referring to the speech in Montreal?

Dr. Boulet: No, the speech that he made at Portland, Oregon.

The Chairman: Perhaps he was using the same speech.

Dr. Boulet: The main reason they want to go into it is that people are looking for methods of using electrical energy which will not require, for instance, coal or petroleum and so on, because we feel that after 1980 all these materials will be used for petrochemical industries that will be developed, and so on and so forth, and that the cost of petroleum will become too expensive. What he said is:

> If a fuel doubling time of less than about ten years can be achieved with breeder reactors, the nuclear power generating systems could become self-sustaining in about 30 years, providing fuel for new reactors as needed and with such efficient use of nuclear fuel that our supplies are sufficient to last hundreds, or even thousands, of years.

So that there will be another possibility of obtaining the power needed.

The Chairman: That is not the same speech. In the speech he made in Montreal he suggested that it would be very desirable if Canada were to devote more time and energy to research in breeders.

Dr. Boulet: Yes. Many people did not like it.

Senator Cameron: I am just wondering how costly it would be, and whether we could avoid duplication with what the Americans are doing.

Dr. Boulet: It is very expensive, but I think it is possible to work in collaboration with the United States in that field.

The Chairman: Sweden is devoting quite some time and energy to that at the moment. But I understand from this discussion that what you intend, at least for the moment, in this field is develop a kind of national capability, not so as to be at the forefront of this, but to be able to be ready to use these facilities if they become available.

Dr. Boulet: That is right. I agree with you.

Senator Blois: I take it you are basing this on the studies being made in the European countries as well as in the United States.

Dr. Boulet: That is right.

Senator Blois: And you are able to contact them and get much of this information from them, and so cut down your own expense a little later.

Dr. Boulet: Yes. I think England will be the first country to come up with a prototype of a breeder reactor. It is due for the end of 1970 or the beginning of 1971. That will be just a small unit. They will have problems to solve and so on. As Dr. Seaborg says, they do not expect to have any commercial unit before 1980 or maybe 1985, but that is such a long-range project that we should start, I think, to prepare. France and England have two small units of 25 megawatts each.

Senator Blois: The British have been working on that for quite some time now, have they not? I think I read about that somewhere just recently.

The Chairman: I read the other day also that France was negotiating some kind of agreement with India with respect to building a kind of prototype breeder. I do not know if they were misquoted, as we all are at times, but saw something to that effect.

Dr. Boulet: Maybe a small unit.

The Chairman: Yes, not a commercial project.

Dr. Boulet: No.

Senator Cameron: The emphasis of this report is that this research centre would be first a national one, and a co-operative endeavour involving, as I indicated earlier, federal, provincial and commercial interests, and the main emphasis will be on applied research.

Dr. Boulet: That is right.

Senator Cameron: Which I think is good. The estimated capital cost is $35 million, with an operating cost of $4½ million a year. How much capital has been invested in the centre so far?

Dr. Boulet: About $6 million up to now. By the end of this year we will have about another $5 million added to that.

Senator Cameron: At the end of this year another $5 million?

Dr. Boulet: Yes, so at the end of the year we will have about $11 million invested. Next year we will have to invest $13 million or $14 million. That will be the time when the high-voltage lab comes into operation, with all the equipment. The lab itself will cost around $8 million, and the equipment about $3 million to $3½ million. At the same time we are starting the high-power lab, and putting in an order for the transformers and so on, and starting the construction of it. So next year we will have to invest about $17 million.

Senator Blois: An additional $17 million?

Dr. Boulet: Yes.

Senator Blois: This is all Hydro-Quebec money at the moment?

Dr. Boulet: Yes.

The Chairman: Have you discussed this with the Ontario Hydro?

Dr. Boulet: Oh, yes. I should maybe have mentioned that. I am discussing it very often with Dr. Waghorn, who is the head of the Dobson Research Lab of Ontario Hydro. We get together and see so many things to be done that, with only 250 people, we will not be able to do everything, so we should divide the work between ourselves. We have decided that that will be the policy that we will follow. Hydro-Quebec and Ontario Hydro are so closely connected that we exchange information on all things.

Senator Cameron: Is there any federal money in the project so far?

The Chairman: No.

Dr. Boulet: Not yet.

Senator Yuzyk: No kind of federal assistance?

Dr. Boulet: Not as yet, but I must say that we are discussing the matter with the Minister of Industry and the Minister of Energy, and I think they are interested in that field, and there is something that will come through. What it will be, I do not know.

Senator Cameron: Of the $4½ million annual operating costs, are you getting any assistance there from outside Quebec Hydro?

Dr. Boulet: No, not yet. I mean, we will get assistance when we get customers using our facilities for tests.

Senator Cameron: This is, in effect, contract research?

Dr. Boulet: Yes, contract research for the prototype of a transformer or the prototype of breakers, and things like that. There we will charge, as they are doing in the European labs, where although they do not make money they have an income sufficient to cover most of the costs.

The Chairman: You have not mentioned, as I understand from the brief, any amount of money that you would expect from the federal Government.

Dr. Boulet: No.

The Chairman: Do you have any amount in mind that you can mention? For instance, is it on a 50-50 basis?

Dr. Boulet: No, no. We just told them that we want to borrow money from, say, the Bank of Canada at a rate of interest that will be lower than the actual rate. I mean, this will be the contribution there.

The Chairman: That would establish quite a precedent. That has never been done.

Dr. Boulet: No? What about the A.C. transmission lines in Manitoba for the Nelson River development?

The Chairman: That was not the Bank of Canada.

Dr. Boulet: Oh, when I say the Bank of Canada, it could be the federal Government.

Senator Cameron: Well then, as of this date, you have not submitted a specific proposal?

Dr. Boulet: Yes, we have. This has been done through the Minister of Industry and the Minister of Energy.

Senator Cameron: But for what purpose?

Dr. Boulet: We just asked them to lend $30 million at 6 per cent interest and we will give obligations, Hydro-Quebec obligations and bonds, which we will start to buy back in 1974 when we will be in full operation.

Senator Cameron: This is not a joint venture then. You are simply asking the federal government to finance it.

Dr. Boulet: We just made a proposal, that is all. Now we are ready to discuss it with them.

Senator Blois: You are ready to get down to hard bargaining.

The Chairman: Fundamentally, up to now you have asked the federal government only for financing?

Dr. Boulet: That is right.

The Chairman: Not for any actual subsidy, or any grant of any kind?

Dr. Boulet: There were some talks in the past. Some ideas that were put forward. One was that the National Research Council could build the high-voltage lab, and operate it. But the difficulty comes when you get a customer; I just do not see a customer, when he wants to have a thing tested in the high-power and high-voltage labs, having to go to two organizations in the same lab.

The Chairman: But what about Atomic Energy?

Dr. Boulet: I do not think they are interested in the high-power, because this is mostly electrical equipment.

The Chairman: Yes.

Senator Blois: Have you made any projection as to what you might have to take in from outside sources in order to carry on? I think there is an estimate of $4½ million for operating costs. Have you any idea, when you get your labs going, what the amount collected from outside firms will be?

Dr. Boulet: I do not think there will be a limit to that, but what we want to do is put a limit on that, because if we do not put a limit on it we will never do research. We want at least to divide the thing, half for testing and half for research. I think that is very important, because if the thing is set up to do research, then we should do research.

Senator Yuzyk: You should be able to get funds for research from the government.

Dr. Boulet: Yes, I think so, with grants for different projects.

Senator Yuzyk: And you are going to make submissions for this?

Dr. Boulet: Yes.

Senator Yuzyk: For, say, research in particular?

Dr. Boulet: We will, yes. You see, we are in the applied field; we are not manufacturers. So what we want to do is to have a manufacturer interested in something, and he himself is going to ask for the money from the Minister of Industry, and we will do the work in collaboration with the manufacturers' people, so when the thing is ready they will be able to take it and put it into production in their own manufacture.

Senator Cameron: Do I understand you are saying that a manufacturer will have a specific project that he would like to see developed, and he will go to the federal Government?

Dr. Boulet: We have already one large one in which we are collaborating on part. We have already started that. I mean, we do not have this in Canada, but if you look at the United States you have the Stamford Research Institute, you have the Battelle Memorial Institute, and you have Bolt, Newman and Beranek.

The Chairman: And Arthur D. Little.

Dr. Boulet: In Boston, yes.

Senator Blois: This will be, Mr. Chairman, I presume, some of the manufacturers' people who are in electronics, or something to do

with that type of work; that kind of industry. Is that what your laboratories would be set up to do?

Dr. Boulet: That is right.

Senator Blois: It could be for public utilities or it could be for private, I take it?

Dr. Boulet: Yes. Most of the projects for public utilities, I think, are of national interest, and I think we will have, for those projects, a good chance of getting grants from the federal government. For instance, we are talking of a national grid system, and this is very important. What would be the voltage we would use? What would be the power, the type of line, and so on? Such projects are very important.

Senator Cameron: Mr. Chairman, Dr. Boulet will know that we have had many suggestions here that as part of our national science policy we should recommend the establishment of a number of centres of excellence or research institutes. It is your thought that this will be one in the field of electrical power?

Dr. Boulet: Yes, that is right. That is what we want.

Senator Cameron: Now you say that the Commission's proposed project is based on a detailed study of the future research needs as foreseen by other public utilities, manufacturers, universities and other government departments. How was this done? Did you establish a working party of representatives of these organizations?

Dr. Boulet: Yes.

Senator Cameron: Have they issued a report? Is there published a report?

Dr. Boulet: No, we do not have any published report, but we have minutes of the meetings. We had meetings with the Canadian Electrical Association, which of course represents most utilities in Canada, and we had meetings with the Canadian Electrical Manufacturers' Association, and at the end of the brief here you have two letters from the board of directors of each of the associations which support that.

As to federal agencies we had three or four meetings with the Atomic Energy Commission, NRC, the Minister of Industry, the Minister of Energy and many others. They were there and they all said it would be a good thing to have such a centre of excellence, as you call it, in Canada. They said we cannot afford two, and I agree with that, but that does not mean that in North America there might not be three or four in the future, if you consider that in North America we have 60 per cent of the installed electrical power in the world.

In Europe they have such labs in each country, although not as big as the one we are going to have, because as far as the energy is concerned, as far as the possibility of taking tests or measurements on the high voltage is concerned, it will be the largest in the world. The main reason why we thought so big is that we found in our visits that each high-voltage lab was outdated after eight years of operation, so it is no use spending $5 million if eight years later it is outdated, and we decided to spend the money and go for at least 20 or 25 years.

Senator Cameron: Have you made any direct study of these small nuclear plants that the Russians are using?

Dr. Boulet: No. I just had that news two weeks ago when I was at a meeting of the Edison Electrical Institute in Portland, Oregon.

Senator Cameron: Is anyone making a study of it?

Dr. Boulet: In the States they have a group studying those small projects, but in Canada I do not know. Maybe somebody in the Atomic Energy is doing that. I think they will be the people to do that, because if we want to compete with the Russians in the north I think we had better start to do something now.

Senator Yuzyk: I am interested in this formula for the distribution of R. & D. funds on page 6, 10 per cent for basic research, 30 per cent for applied research, and 60 per cent for development. It is rather low on basic research, from many of the briefs that we have had submitted to us, and I understand there are practical aspects as to why you would have 30 per cent for applied research, and 60 per cent development. How did you arrive at this formula?

Dr. Boulet: If you look over the research work being done in the States, you will see that last year or the year before they spent close to $26 million in research for the government, but close to 75 per cent of that amount is in development and applied research. They are spending only five per

cent of their national total budget in fundamental research. Another point is that if you go to Sweden you will find they do very little fundamental research, because fundamental research, from my point of view, is published, and if you want it you can pick it up in the open literature most of the time. But development, that is where we do not have anything, and that is where we should develop something soon to make our own products, and that is what they have done in Sweden.

Take the D.C. valve: all the countries in the world are depending on them for that. They went into the development of the thing. As you know in the steel industry, they have developed special steels, and people are depending on them. But they do fundamental research in the university. They have, of course, the national atomic laboratories.

Senator Yuzyk: Here I understand that you do not recommend reducing the amount of money for basic research, but increasing...

Dr. Boulet: No, increasing the amount for the applied and development.

Senator Yuzyk: Yes, that is right, and development would include innovations?

Dr. Boulet: Oh, yes. I mean, in development you might be able to get the know-how from another country. We see that the Japanese are coming and producing many products, but in their case they did not do the research; they bought the know-how. It might be a question of buying the know-how if we find we need something that has been developed by another country, or the applied research that has been done in other countries, and applying it here.

Senator Blois: I think a number of the briefs that have been presented to us, and also the people presenting them have pointed out that we in Canada were not spending enough on development. That seemed to be the general feeling, and I think your line follows along on what we have heard here in the past, that we should spend more on development. A lot of work has been done, but we have not made actual use of it to the extent we might.

Dr. Boulet: Yes.

The Chairman: When you said that you were only trying to develop a kind of national capability in the field of breeders, I suppose that this would be the same situation with respect to nuclear fission.

Dr. Boulet: That is right.

The Chairman: You are not intending to become the world leader?

Dr. Boulet: No, but we have at least a small group of people who visit laboratories and go to meetings; they discuss with people, especially those in the government laboratories in the States, where you can get anything you want in the reports. If something comes out of that then we will have a group of people with that background.

Senator Cameron: On page 7, Mr. Chairman, the report says, "However, work in the field of electrical energy is negligible except for nuclear conversion." This is a pretty sweeping statement. If it is true—I have no reason to doubt it—does this suggest that the universities are not doing what they should be doing in terms of training their engineers?

Dr. Boulet: They are doing quite a bit of work on the electrical side, but mostly on communications, and the main reason is because they do not have the money to set up the very expensive equipment needed to do applied research in the power field. In our case, we want to open our labs to any graduate student that wants to prepare his thesis in that field. They do not have the facilities in the university. If the universities agree with that—some of them have already agreed—they could send their men to prepare their theses. That is what they are doing in Europe, but here in Canada I think the universities have said that the doctorate degree is one of their products, and that they only could give it. I agree with that, but on the other side I think they should use more extensively all the facilities available in Canada in order to proffer the degree of PhD. in that field. Of course, this will cause a few problems, but they will just have to hire one of the research men in the governmental departments, in the NRC or Atomic Energy, or in our case one of our men, as a visiting professor to make sure that the work being done by the student is his own work, and not the work of a group of people.

Senator Cameron: I think you have probably put your finger on it in saying that the reason why they have not done more is the cost of the installations.

Dr. Boulet: That is right.

Senator Cameron: But it does seem that in a country where the sources of electrical energy are in such abundance, as a matter of university policy and national policy, we should have done more to meet this need.

Dr. Boulet: Yes.

Senator Cameron: Along with that, on page 10 you say:

> One of the major problems in Canada and North America generally is the present tendency for engineering students, including the best ones, to go in for fashionable fields such as computers, space research, data processing, etc. This tendency is so widespread that we lack good researchers and even good engineers in the field of energy.

Dr. Boulet: And that is true even for the States, to such a point that at one of the meetings of the power group of the IEEE about three years ago they even suggested starting up a new technical university where the student could do some work on power.

Senator Cameron: We have had suggestions of this kind, not specifically on power but that separate research institutes be established. I am wondering if this relates to what the student activists are saying about the university training being irrelevant? Do you think the training in engineering has been irrelevant to the world in which we are living?

Dr. Boulet: No, otherwise I would be condemning myself, because I have been 17 years in the university. But I think the things that we are doing now in the university can be done better. What we need most is collaboration between universities, and collaboration between universities and industries.

Senator Cameron: Then on that particular point, do you see practical measures by which the resources we have for research in the universities, in the federal government, in Quebec Hydro, and in private concerns, can be meshed more effectively than they are at the present time?

Dr. Boulet: First of all, let me say that before the war the university professor had many contacts with industry, but they were on an individual basis. Right after the war, when everybody wanted to go into electronics—I am talking about electrical engineering, but I do not think there is any difference in other fields—the university professors decided to go into communications, electronics, satellites, and all of those things. We did not have much in Canada in that field. Furthermore, the impression in the universities was that the power field was a very conservative field, that there was no research to be done in that field, and no problems, and so on and so forth. So, in many cases we stopped giving courses in the power field, and we were giving to our students mostly a course for physicists—theory, and no application and no problems.

We developed such a mentality that a professor from McGill University could tell me the other day, "You know, we are graduating our fifth generation of doctorates in electrical engineering this year. This generation was produced by the fourth one we had, and the fourth by the third, and the third by the second, and the second by the first, and not a single one of them ever went into industry to have training, so they do not know the industrial problems". I think one of the problems in North America is that we are graduating young men with graduate degrees, and we are putting them in charge of a group of students to teach them. If you go to Europe, it is the reverse: a man becomes a professor in a university only after he has reached a high point in his career and he is known, and the appointment is made on a competitive basis, so he has 15 or 20 years of experience.

Senator Cameron: Then as an ex-professor have you some practical suggestions to make as to how we might get this integration between industry and the university, which I quite agree is necessary?

Dr. Boulet: There are possibilities. In our case, we have contacted the universities ourselves. I think this might be done. The government laboratories should take the first step. I think they have already done that, but I do think there might be a way by which—and the federal government and the provincial governments are trying now to have interchange between industry and the univerties, on a little scale in Canada—by which you take an engineer in industry and send him to the university to teach a course and discuss with the people there, and you take a professor at the university and send him into industry to see what are the practical things. By doing that I think you will get back to the contact between these people. I do not believe

that setting up a national organization to take care of that would be of any help. I think the people have to be in contact on an individual basis.

Senator Cameron: In other words, it becomes a question of attitude.

Dr. Boulet: That is right.

Senator Cameron: I have been preaching this for 20 years and have not got too far, but I have the feeling that the Americans have succeeded to a much greater extent than we have in having an exchange between industry and government.

Dr. Boulet: What they are doing in the States is to make a professor free one day a week to go into industry to work on a project. But the point is that they have so many interesting projects among the manufacturers in the States that it is easy for them, but I think they went a little too far from my point of view. If you consider a university such as M.I.T., where they have set up three or four large research organizations which are mostly industrial research organizations mainly doing research for the government, you find those research organizations have become larger than the university itself. When you discuss this with people in the States now you find many manufacturers start to resent that, because they feel that these industrial research labs are in direct competition with themselves.

The Chairman: It is a matter of equilibrium, or balance.

Dr. Boulet: Yes.

The Chairman: Are there any further questions?

[*Translation*]

In conclusion, I should perhaps like to ask you a series of questions which would, to some extent, summarize the discussion we have had this morning. First of all, if I understand correctly, the institute you plan would have not only Canadian but international openings?

Dr. Boulet: You are perfectly correct, Mr. Chairman.

The Chairman: Secondly, you estimate an annual operating cost of approximately 4 1/2 million dollars?

Dr. Boulet: Yes.

The Chairman: Of which almost half would be financed by contracts?

Dr. Boulet: Yes, if possible.

The Chairman: If possible, provided obviously that it does not interfere too much with research.

Dr. Boulet: That's right.

The Chairman: And the rest would be financed either by Quebec Hydro or by subsidies from research organizations of the federal government who are interested in furthering our knowledge in the field of energy.

Dr. Boulet: That's right.

The Chairman: And, thirdly, there is the problem of fixed capital formation which would amount to approximately 35 million dollars?

Dr. Boulet: Yes.

The Chairman: On this subject, up to the present time, in your discussions with the federal government, you have requested only a loan?

Dr. Boulet: That's right.

The Chairman: You asked for a loan of 30 million dollars?

Dr. Boulet: Yes.

The Chairman: And in return, Quebec Hydro would give the government, or the government agency responsible for the financing, bonds which would be...

Dr. Boulet: Redeemed.

The Chairman: ...redeemed after a certain period, let us say in 1975, 1980, when your research project would be completely launched?

Dr. Boulet: That is correct.

The Chairman: It could also produce income?

Dr. Boulet: Yes.

The Chairman: Then, this is the essential point because here in the brief, various interpretations are possible; in short, at a certain time, we are to understand that you had requested subsidies from the federal government?

Dr. Boulet: No, we do not believe that subsidies for definite research programs...

The Chairman: That is another matter.

Dr. Boulet: That will be another matter but it will be very easy to pass.

The Chairman: Now, there is the idea of fixed assets.

Dr. Boulet: No, it was requested in our brief but at the time we were proceeding along a formula that was as yet to be determined.

The Chairman: Then, it is the formula, in short, which...

Dr. Boulet: Actually, we have made the request. Now the federal government will probably submit a counter-proposal and through discussion we will reach an agreement.

The Chairman: At the present time, you have not proposed joint financing as happened, for example, for the construction of prototypes of nuclear generators?

Dr. Boulet: No, I think that one of the reasons is that our high power laboratories will operate with the Quebec Hydro network. Therefore, we must constantly work in close co-operation with the operating personnel so that we will not simply set aside the other networks of Quebec Hydro and then have too many of our customers... It is for this reason that it is not an institute which can be totally separated from the parent company; it depends on our operating staff and services.

[*Text*]

Senator Yuzyk: Perhaps I could ask one more question. We have asked this question of a number of witnesses, and I am going to ask it of you: What would the attitude of Hydro-Quebec be towards the possible establishment of a Ministry of Science? Do you think you would be favourably inclined, or otherwise?

The Chairman: I think that is a little too much to ask of a provincial public servant.

Dr. Boulet: I would have to answer it on a personal basis. I am not a public servant. We are a Crown company.

The Chairman: Yes, but you are a public servant. You are not a civil servant; you are a public servant. I think perhaps you might ask him that in the corridor.

Senator Yuzyk: I thought he might have some general ideas along these lines. I am not asking for any basic commitment, but you may be faced with that problem in the future.

Dr. Boulet: There is one thing now, when you see that money for research comes from many different ministries. I am afraid, if you appoint a Minister of Research, that all the money to be given will come under him, and he will have to set up special boards to make studies for things like that. He will have to go to all the different ministers in order to find out whether a project is a good one, or a bad one. Personally I think the appointment of a Minister of Science and Technology and so on might not be a bad thing, but if you appoint a lawyer as Minister of Science, well, that might well cause verbal pollution.

The Chairman: Or a chemist.

Dr. Boulet: That would be even worse. If you appoint a physicist, he will start to develop physics. If you appoint an engineer, he will go and apply it only on applied research. I feel myself that each ministry which needs research, such as forestry, mining resources and so on, knows its own problems. Up to now they have tried to do themselves all the research they have needed, and I think that is where the thing goes wrong. They should give a little more to the outside industries, and the universities, and so on, but they will be the people able to judge the results of their work. If you set up a Minister of Science and expect him to do all that, you will be duplicating all the work being done. He will set up a nice organization with 500 people, so you will be spending money for administration instead of for research.

Senator Yuzyk: You do not think that would add to efficiency at all?

Dr. Boulet: Maybe, and maybe not.

The Chairman: It depends on the concept you have of such a department. If he is responsible for all the research going on within the federal government, and all the grants programs, there would be the results that you envisage. But if this minister is mainly responsible for co-ordination and seeing that the balance is respected between basic research, applied research, and development, then I think that...

Dr. Boulet: In that sense it would be much better, yes. It depends how you define the ministry.

The Chairman: Yes. Again it is a question of definition.

Dr. Boulet: It is a question for the future.

Senator Blois: Mr. Chairman, I might ask one other question which I think Dr. Boulet has answered to a certain extent. In the discussion we have had so far I believe you were asked whether the Atomic Energy Board and the Science Council of Canada were favourable to what you are doing. I take it that they feel there is need for it. You would not interfere with the work that they have been doing or suggesting in the past? Am I correct in that?

Dr. Boulet: Yes. I do not know about the many people in the Science Council; I do not know if the project as such has been presented to the Science Council. We felt in our discussions with the federal Government that if they wanted, they could present it to the Science Council. It is not ourselves that have to present it.

The Chairman: Yes. I understand that the Science Council does not receive representations, projects, or proposals from outside.

Senator Blois: Exactly.

The Chairman: It is up to the Government, if they so choose, to present that to the Science Council.

Dr. Boulet: Maybe they felt it was so clear that they did not need it.

Senator Blois: In some places in the brief mention is made of the amount of money spent in other countries—the United States and European countries—by various municipalities, commissions, and electric utilities. Have you any idea of the amount of money that would be spent, say, by industry in getting technical information?

Dr. Boulet: That is very difficult, because even in our case, when we did put in an order for the first 735 Kv. equipment required for our lines, we asked for bids. Part of the bid was for the development of the thing, so how much we put into that I do not know. That is a very difficult thing to say.

Senator Blois: It would be a pretty large amount, I take it.

Dr. Boulet: Oh, yes, I have a figure. Just for the optimization of our power on the transmission lines we spent more than $1 million.

Senator Blois: As much as that?

Dr. Boulet: Oh, yes.

Senator Blois: Then would private industry be spending a fairly large amount as well, although not to that proportion?

Dr. Boulet: I do not know. I have tried to get, and I think the Minister of Industry tried to get, some figures on that, but we could not. The only thing I can say is that KEMA in Holland and CESI in Italy are getting all their money from Canada and the United States.

Senator Blois: Is that so? There must be quite a lot then, because that is a big organization.

Dr. Boulet: Yes, each one of them, because in KEMA they have about 260 people and in CESI they have about 250.

[*Translation*]

The Chairman: Dr. Boulet, on behalf of the members of the committee, I wish to thank you and express our gratitude to you for coming today to present this project to us and to agree to answer other questions which went well beyond the scope of your brief. Thank you very much and good luck.

Dr. Boulet: Thank you, gentlemen.

The Committee adjourned.

APPENDIX 177

REPORT

submitted to the

SENATE

SPECIAL COMMITTEE ON SCIENTIFIC POLICY

by the

QUÉBEC HYDRO-ELECTRIC COMMISSION

March 25, 1969

SUMMARY

The first section of this report contains the principal recommendations of the Quebec Hydro-Electric Commission. These recommendations are based on the fact that in Canada electrical energy will experience the highest growth rate of any form of energy between now and 1980.

The Commission believes in the need for an electrical research institute to facilitate development of the Canadian electrical industry, and recommends:

1) the participation of the federal government in its establishment

2) grants for its research programs.

The Commission is of the opinion that the most promising research related to new powerhouses lies not only in the conventional fields such as hydraulic generation (Canada already has several laboratories of this type), or nuclear or conventional thermal power stations, but also in the realm of fast breeder reactors.

Moreover, the Commission considers that thermofusion is a subject for long-term research.

To meet the demand for electricity in remote regions, the Hydro-Quebec Institute of Research will make a complete study of the problem and especially the use of fuel cells or hybrid batteries.

In the field of power transmission, the Commission will make available to governments, public utilities, consultants and manufacturers, laboratories that will enable them to undertake most of their research projects for the development and testing of electrical equipment at all present and future currents and voltages.

Naturally, these laboratories will permit the study of distribution problems.

Specialists in system studies will be able to carry out the analytical studies that are presently done in American laboratories.

Finally, the Commission recommends that the federal government subsidize technical research on the applications of electricity.

The second section analyzes the technical problems of public utilities and manufacturers of electrical equipment. It underlines the importance of electrical energy in the Canadian economy.

The third section deals with the Institute's aims, fields of research, organization, staff training and the cooperation required to attain its goals.

Section 4 analyzes the major research being carried out in the fields of generation, transmission, distribution, automation and system studies.

The last section deals with the physical installations and their cost. Capital costs will be about \$35 million and annual operating costs, \$4½ million.

RECOMMENDATIONS

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1.0 RECOMMENDATIONS

1.1 General

Between 1950 and 1965, the total installed capacity of electrical power stations more than doubled in order to meet demand. Planning groups in Canadian electrical utilities forecast that by 1980 this capacity will be three times greater than it was in 1965.

During the last two years, orders have been placed to equip new power stations whose capacity will be about 60% of the capacity of all existing plants. In the next few years, it will be necessary to undertake construction of an even greater number of power stations, which may be of the conventional thermal type, nuclear or hydraulic. Forecasts indicate that nuclear stations will account for about 50% of the increase in capacity between 1965 and 1980. They also indicate that the growth rate of electrical energy will be the highest of all forms of energy and that by 1980 electricity will predominate in the energy market. Annual Canadian investments will exceed $3 billion and will certainly constitute a firm base for the development of exports. Exports may increase if the federal and provincial governments approve a renewed policy of aid to research and development in the field of electrical energy so as to make new equipment available to public utilities and manufacturers all over the world.

1.2 <u>Canadian policy for aid to research</u>

Hydro-Quebec supports the following four recommendations made by The Engineering Institute of Canada in a report published in January 1967, entitled "A Canadian Policy for Research and Development":

"It is recommended that:

1. Canada pursue a national research policy as follows:

   a) Attain the same proportionate research and development spending as in leading countries, but with emphasis on industrial research and development.

   b) Increase direct government support to applied research and development in industry.

   c) Provide research funds separately from teaching funds.

   d) Recognize the need for research to pay off eventually in terms of socio-economic consequence, with priority of grants to competent workers on projects of potential practical importance.

2. Support of applied research and developmental work be given first priority, with a target of providing 750,000 new jobs by 1970, from technical innovations arising from

such support, in recognition of the inescapable fact that all benefits and activities in Canada are dependent upon a viable and tax-producing industrial base.

3. National research and development investment be guided into a distribution of 10% to basic research, 30% to applied research and 60% to development, by increasing the expenditures on industrial research and development activities, without reducing the current outlays for basic research.

4. Priority be given to the support of research and development for the science-based industries."

Hydro-Quebec, like all other Canadian public utilities, should be considered as an enterprise that manufactures and distributes a product. These public utilities should, in association with equipment manufacturers, assume responsibility for the study, research and development of the methods and equipment used in electrical systems. Because Canada lags in this field and above all, because of its importance to the Canadian economy, the federal government should participate in the financing and operation of new laboratories such as Hydro-Quebec's Institute of Research, which will be known under the acronym IREQ.

Obviously, Canada cannot at present afford more than one research and testing centre like the one described in Section 5.0 of the report. The executive of the Canadian Electrical Association and the Canadian Electrical Manufacturers Association have unanimously endorsed our project, as attested by the two letters attached. The Commission believes that the federal government should heln Hydro-Quebec to establish this institute of national importance, whose total cost will be $35 million.

The Commission further recommends that the federal government subsidize the Institute to support research projects that are common to public utilities in several provinces or to several equipment manufacturers. This policy on the part of the federal government would enable our equipment manufacturers to become competitive in world markets and thus create new employment.

The Commission agrees to treat as confidential any research or testing done for equipment manufacturers. The Institute will make its research personnel and laboratories available at a cost comparable to or lower than that charged by European laboratories.

1.3 Fields of research

In its policy of aid to electrical research, the federal government should consider short-term projects (5 years or less) and long-term projects (5 years or more). Problems of generation, transmission, distribution, applications and system studies should also be considered. The Commission considers that Canada should pay particular attention to the following fields:

1.3.1 Generation

All research in the field of generation has been outlined in Section 4 of this report. As a result, the Commission recommends that in addition to present expenditures on research in electrical generation, the federal government could and should consider the following projects:

1.3.1.1 Fast breeder reactors.

1.3.1.2 Thermofusion.

1.3.1.3 Generation of electricity in remote regions.

1.3.2 Power transmission

Aside from the methods of generating electricity, it is now recognized that the problem of power transmission will always be present. Public utility planning indicates that it will be necessary to study the following methods of transmission by overhead lines:

1.3.2.1 at a.c. voltages of 1000 kV, 1200 kV and even 1500 kV.

1.3.2.2 by d.c. overhead lines at $\pm$ 600 kV and 800 kV.

1.3.2.3 with conventional cables at voltages up to 500 kV.

1.3.2.4 with cooled cables, using cryogenics or superconductors.

Transmission also poses problems of measuring electrical quantities, research, development of equipment, prototype and acceptance testing at all values of voltage and current. All these important problems have so far been negiected in Canada.

1.3.3 Distribution and Applications of electrical energy

1.3.3.1 Several Canadian manufacturers specialize in distribution problems but equipment testing and research laboratories do not exist. Moreover, our manufacturers must use foreign laboratories to verify that their products conform to Canadian standards.

1.3.3.2 Applications

The increase in the demand for electricity is due in large part to the introduction of new products that consume electricity. Ontario Hydro's Dobson Laboratories have already developed useful new products that are being produced in quantity.

The Commission recommends that the federal government's research policy favor the creation of new markets to increase employment.

1.3.4 System studies

The Commission is convinced of the need to establish a group of mathematicians to devise new methods of studying electrical systems, develop automation and improve system operation. At present, Canadian public utilities, with the possible exception of Ontario Hydro, depend almost entirely on American laboratories for their system studies.

1.4.0 Hydro-Quebec's Institute of Research

Aware of its responsibilities, the Commission decided to create a research institute to study some of the problems just mentioned. In particular, IREQ will be responsible for studies and research on thermofusion and fuel cells in the field of electrical generation.

However, its main effort will be directed to the transmission and distribution of electricity. The Institute is building High Voltage and High Power laboratories with the instrumentation needed for research and development of all types of a.c. and d.c. transmission and distribution equipment at voltages from 600 volts to 1200 kV and currents from several amperes to 500 kA.

These laboratories will be available to all Canadian manufacturers for individual or group research to enable Canadian industry to develop and test all types of electrical equipment.

Groups of researchers will also undertake studies on electrical systems, the automation of these systems, the materials used in equipment and cables and, finally, the associated mechanical problems.

The required investment is about \$35 million and the annual operating budget about \$4½ million. In establishing IREQ, the Commission seeks the cooperation of all Canadian organizations and recommends the financial participation of the federal government according to a formula to be determined.

R E P O R T

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2.0 INTRODUCTION

2.1 History of the Quebec Hydro-Electric Commission

The Commission and its subsidiaries operate an electrical power system. This public utility is engaged in the generation, transmission and distribution of electricity in the province, which is Canada's largest in area and second in population. Hydro-Quebec has jurisdiction over all electricity distributed in Quebec, except for small quantities distributed by certain municipalities and even they, in most cases, obtain their power from the Commission or its subsidiaries.

The Commission was established in 1944 by an Act of the Provincial Legislature and is a Crown Corporation. The Act states that the role of the Commission is to supply electric power to municipalities, industrial or commercial undertakings, and to the citizens of Quebec at the lowest rates consistent with sound financial administration.

At the end of December 1968, the Commission and its subsidiaries were operating 52 hydroelectric power stations with a total installed capacity of about 7710 MW, and 17 thermal and diesel stations with a combined capacity of 655 MW. The 1967 Annual Report is included in Appendix A and the 1968 Report will follow as soon as it is published.

2.2 Investments

The Commission's role in Quebec is no different from that of public utilities in other provinces. Last year, investments by all Canadian public

utilities and manufacturers amounted to more than $1½ billion and it is estimated that in 1980, these investments will be more than $5 billion: by the end of the century they will exceed $8 billion. These investments are made solely to meet the normal growth in demand by customers of each Canadian utility. To meet this demand, Hydro-Quebec must, for its part, increase installed capacity from 8500 MVA to about 70,000 MVA by the year 2000.

Up to now, the principal source of electrical energy in the Province of Quebec has been the development of hydraulic resources. Ontario and the other provinces use, in addition, thermal power stations burning coal, fuel oil or natural gas.

2.3 Problems faced by public utilities

In Quebec, we are faced with the following problems: the most economically feasible hydraulic sites are those furthest from the load centres. If we intend to develop these sites, we must take into account the transmission of power over great distances. But, on the other hand, if we follow the example of our neighboring provinces by building thermal or nuclear power stations, they must be extremely large (1500 to 2500 MVA), in order to be profitable. By their very size these power stations require higher voltage transmission lines and heavier electrical equipment. Hydro-Quebec has first-rate experience in this field because it established a world record with its existing 735-kV lines

for transmitting power from Manicouagan. Planning indicates that in future we may have to construct extra-high-voltage direct-current lines to maintain the stability and reliability of the system.

All Canadian provinces have a duty to provide electricity to populations in remote regions. The present cost of generation requires that new methods be found to supply these regions. After 1980, this type of demand will exceed 2000 MVA in units of 50 to 500 kW and no integrated program exists for obtaining a solution to this problem.

2.4 The state of research in Canada

With the exception of Ontario Hydro, very few research programs exist in Canada in the fields of generation, transmission and distribution of electricity. Furthermore, our Canadian manufacturers must often use foreign laboratories, especially those in Europe, for testing their own electrical equipment

Aware of its responsibilities in the technical field and desirous of fulfilling its mandate to provide electricity at the lowest cost, the Commission decided in 1967 to create an Institute of Research, which is known by the acronym IREQ.

3.0 HYDRO-QUEBEC'S INSTITUTE OF RESEARCH

3.1 General

After two years of studying the existing state of knowledge about

the generation, transmission and distribution of electricity in North America and the entire world, Hydro-Quebec decided to concentrate its research in High Power and High Voltage laboratories. These laboratories will be equipped to enable researchers to study lines and equipment at hitherto untried voltages and, in addition, meet the needs of Canadian manufacturers and utilities for studying all present or future voltages and power ratings.

These two years of study revealed that Canadian and American utilities, as well as equipment manufacturers, depend on European laboratories such as KEMA in Holland, CESI in Italy, EDF in France and CEGB in England. Many small, medium-size and large Canadian and American firms use the services of these European laboratories, which are independent of manufacturers, for technical studies and equipment-testing according to international standards. However, none of these existing laboratories can fully apply these standards, mainly because of lack of power, and only IREQ will be able to do this.

3.2 Objectives

The electrical industry has made remarkable strides so far in this century. But looking to the future realistically, there is reason to believe that progress and technical achievements must be carried out on an even larger scale. The world of tomorrow, which is called the "space age" or the "technological era", will be a world in which energy will play a predominant role, with

research as the key element.

3.2.1 Solution of the problems

Hydro-Quebec's first aim is to solve the numerous technical problems associated with the construction of powerhouses and the operation of more complex transmission and distribution systems. The problems to be solved in this vital field are truly immense. To reach this first objective, Hydro-Quebec has established the principle that there shall be no duplication of services already available in existing Canadian laboratories.

3.2.2 Industrial development

The Commission is also aware that if Canadian industry wishes to export new methods of transmission and new equipment, it is necessary to provide our consulting engineers and equipment manufacturers with absolutely first-class laboratory equipment, testing means and research personnel.

3.2.3 Technical obsolescence

The dangers of technical obsolescence haunt all engineers and researchers but especially those in the field of energy. Our laboratories, in a well-balanced research institute, will enable these engineers to remain up to date and productive by following training courses lasting from several months to a year.

3.3 Research program

To be effective, a program of research in electrical energy should cover the following subjects:

3.3.1 Generation: Fuel and energy-conversion technology.

3.3.2 All aspects of power transmission: Transmission at hitherto untried voltages.

3.3.3 All stages of distribution: Higher voltages, and techniques for developing economic underground distribution systems, utilizing new materials and new insulation methods.

3.3.4 All forms of utilization: the complete range of electricity needs, from the tiniest bulb using a fraction of a watt to large motors or furnaces using several hundred thousand kilowatts.

3.3.5 System problems: New methods of analyzing networks.

All of these problems will be analyzed in detail in a later section.

3.4 Cooperation

Any research centre must cooperate with all existing centres. It is often said that "research knows no frontiers."

This cooperation is carried out mainly on a personal level: experts in the same field discuss their common problems at meetings and symposiums.

The participation of learned societies, international organizations or various governments at these meetings is a source of enrichment for a research centre.

After a few years of operation, this cooperation will enable IREQ to make its researchers available to international organizations for aid to developing countries.

Cooperation within a country involves coordination of all the research work done in various laboratories, that is, governmental, industrial and university laboratories.

3.4.1 Cooperation with government laboratories

The federal government has numerous laboratories with experienced researchers. However, work in the field of electrical energy is negligible, except for nuclear conversion. Already, IREQ's organization and fields of research have been discussed at several meetings with officials of the various laboratories and, in particular, the National Research Council, Atomic Energy of Canada Limited and the National Defence Council. The people in charge of these laboratories have promised to cooperate in the establishment of our new centre.

IREQ will certainly work in close cooperation with existing research centres and those to be established by the provinces, especially those in Quebec.

3.4.2 Cooperation with industry

As mentioned at the beginning of this report, Ontario Hydro's Dobson laboratory is, at present, the only centre in Canada doing research in electrical energy. The excellent cooperation that already exists between Hydro-Quebec and Ontario Hydro will continue. Discussions with the management of the Dobson laboratory and some of its chief researchers indicate clearly that research problems pertaining to generation, transmission and distribution are so numerous that it would be very easy to divide the projects between the Dobson laboratory and IREQ. Moreover, research projects of interest to both organizations will be studied jointly.

It is well known that Canadian equipment manufacturers lack the financial resources to establish centres that would enable them to make innovations in the field of electrical energy. Hydro-Quebec believes that the creation of its Institute of Research will be extremely profitable to Canadian industry because its laboratories will enable manufacturers to produce new prototypes which, in addition to satisfying the home market, can be made available for export. To satisfy the needs of Canadian industry, the Institute of Research will offer two types of contracts: group or individual.

3.4.2.1 Group contracts: Participants in a group contract are motivated by the fact that reaching the desired goals is vital to their individual and collective progress. Once the goals are reached, each participant is free to apply the findings to the limit of his organization's capacities. Participants in a group research effort are not necessarily members of the same industry. In fact, the more far-reaching the objectives of the joint project, the more likely it is that members of diverse industries will be included among the participants.

3.4.2.2 Individual contracts: The Institute will offer qualified staff and ultra-modern equipment to companies. In individual contracts, the client's staff may be integrated with the Institute's research staff to establish a good liaison and meet the client's ob ectives. IREQ can be of great help to manufacturers who have had to postpone certain projects because of other important research inside their own laboratories; to an enterprise whose research personnel is operating in unfamiliar technology; and finally, to organizations whose projects are handicapped by lack of special equipment or funds. These individual pro ects can succeed only if there exists a confidential relationship between IREQ and the client. The Institute's attitude in confidential matters will be similar to that practised by legal and financial advisers.

3.4.3 Cooperation with universities

One of the major problems in Canada and North America generally is the present tendency for engineering students, including the best ones, to go in for fashionable fields such as computers, space research, data processing, etc. This tendency is so widespread that we lack good researchers and even good engineers in the field of energy. Statistics show that if engineering departments at universities have research programs directed to energy-conversion or transmission, a greater number of excellent graduates are attracted to this field and the proportion is even higher among post-graduates.

If a student is active in research in this field it has a great influence on his choice of career. From the purely selfish motive of attracting the best graduates to the Institute, Hydro-Quebec has established a budget for granting research contracts to universities. The contracts must be for applied research in fields useful to public utilities. Besides engaging the attention of undergraduates, these studies would help to train much-needed researchers. An Institute research worker will maintain contact with the university research workers during the lifetime of each contract. In this way, the university, professors and students will be in constant touch with the needs and progress of energy research.

The Institute of Research also intends to use the services of some professors and young university researchers in order to keep them abreast of the latest developments in energy research.

3.5 Hydro-Quebec's Institute of Research

Why is a research institute attached to a public utility? Because Hydro-Quebec hopes thereby to achieve the excellent results obtained in all of the most industrialized countries in the world. In the United States, Japan, Great Britain, Sweden, Germany, Italy and France, it has been realized for several years that attaching a research centre to an industry with problems to be solved motivates researchers and gets better results. The main reasons for attaching a research centre to an industry are to solve problems, plan for the future and train staff. It is moreover the best way to attain the objective of lower costs and increased productivity.

3.5.1 Applied research

Public utilities do not have to discover new laws of science derived from natural phenomena or engage in fundamental research because their role is to supply reliable low-cost energy. Basic research is done by universities and government laboratories. IREQ will be concerned exclusively with applied

research and the development and improvement of equipment. The difference between fundamental and applied research lies more in the results sought than in the methods used to obtain them. Researchers should be chosen for the interest they display in the field of energy.

3.5.2 Test laboratories

Since a public utility does not produce its own equipment, it must work in close cooperation with manufacturers. Its electrical system enables construction of a laboratory with the power necessary for testing prototypes and equipment. The Institute's high-power test bank, associated with the high-voltage laboratory, will enable Canada to participate in the establishment of standards for electrical equipment and power transmission. The staff of a test centre is made up of engineering specialists assisted by trained technicians. For training purposes, the manufacturers' employees must be allowed access to the centre, and exchanges of information must be encouraged between the research worker, the project engineer and the operations engineer working in the same field.

To sum up, Hydro-Quebec considers that its research activity should be limited to applied research, the development and improvement of equipment, and testing.

3.6 Management and organization

3.6.1 Internal organization

The internal organization of the Institute of Research is entrusted to a committee composed of the heads of the various laboratories, under the chairmanship of the Director. The main organization-chart in a research centre should be completely horizontal, meaning that between a research worker and the Director there is only one level of administration - namely the scientific director of each laboratory in the centre.

3.6.2 General administration

The general administration takes into account the national and international character of the Institute. Operation of the High Power laboratory depends entirely on the Hydro-Quebec system, the use of which has permitted a saving of $30 million in the capital cost of the laboratory. The Commission's decision to make its Institute of Research "Canadian" implies the participation of outside organizations. But the close cooperation of Hydro-Quebec is essential because the Institute depends on its power network. The Commission welcomes the participation of representatives of manufacturers, other public utilities, universities and governments, under the terms of an agreement that has not yet been finalized.

3.6.3 Working language

IREQ considers that its working language should be French. This policy will enable English-speaking scientists wishing to study or improve their knowledge of the French language to do so while pursuing their research work at the Institute. In addition, the establishment of a research centre where the working language is French will enable French-Canadian researchers to work in their own language. However, IREQ is also aware of the necessity for its research workers to speak the language of the client.

3.7 Staff

The Commission is of the opinion that the fundamental element of a research centre is not the construction of laboratories or their equipment but rather the research personnel. About 70% of the operating costs of any research centre consists of salaries paid to research workers and their technical assistants.

The very nature of a researcher's work requires that, apart from previous training, he have three to five years' additional training before becoming productive. His critical sense, imagination and skill in experimentation must reach a certain level of maturity. He must have certain personal qualities such as intelligence, the desire to solve problems, initiative,

ability to reason logically, a taste for scientific reading, facility in expressing himself and some manual dexterity. Some people think that if you have the right instrumentation, research is easy; such people confuse simple measuring with studies in depth.

The basic reason for this long preparation is that the research worker enjoys complete freedom of action within the framework of his specialized activity and his allotted budget. If he is inexperienced, serious losses in time and money could result. In certain fields, he must not only make measurements but he must also create the required instrumentation and determine the accuracy of his own studies.

First of all, and before undertaking any research whatever, Hydro-Quebec must hire responsible and experienced researchers. This key personnel must possess the necessary technical qualifications and experience.

Some specialists in the applied sciences from various countries have already joined the Institute, several of them being international authorities in the fields of High Voltage, High Power and Electrical Systems. Several Canadians presently working in the United States will soon join the Institute staff.

The National Research Council has willingly lent us the services of its experts to help us determine the characteristics of experimental alternating-current and direct-current transmission lines.

The principal aims of the Institute are to meet the needs of public utilities and Canadian manufacturers. It would seem logical to engage Canadian researchers in the future. Hydro-Quebec has thus established a policy of attracting and training its own staff and already many young Canadians are being trained in well-known European laboratories such as EDF and CESI. The CEGB laboratories in England, KEMA in Holland or ASEA in Sweden will also be used. Thus, when our laboratories go into full operation, the staff will already be trained.

3.8 Choice of research projects

In choosing research projects, Hydro-Quebec feels that the following three principles should be adhered to:

3.8.1 Feasibility of the project

The solution to the problem should result in a net gain (bearing in mind the uncertainties of research work).

3.8.2 Time limit

Applied-research problems are rarely solved in one or two years. Putting a prototype into production also requires a long period that may be anywhere from two to four years.

3.8.3 Origin of projects

At the start, Canadian public utilities and electrical manufacturers will be the source of most research projects. After several years of operation and experience on the part of the Institute's researchers, useful projects will originate within the Institute itself. Canadian industry will also provide the Institute with a large number of problems to be solved.

4.0 FIELDS OF RESEARCH

Initially, the Institute's choice of research fields was determined by a complete analysis of the problems to be solved. We will give a qualitative description and a quantitative analysis of the problems envisaged, the prospects for application and the present state of research. We will then describe the laboratories themselves, the space required, the number of researchers necessary, the auxiliary staff, and the total cost. A bibliography of relevant technical publications is attached. It must be remembered, however, that the publications consulted were produced by researchers strongly motivated by the desire to obtain positive results.

The fields of energy conversion, transmission and distribution will be studied. In the majority of cases, the assessment of future possibilities is based on conclusions reached by highly qualified individuals or groups.

4.1.0 Magnetohydrodynamics

Note: The figures in parentheses refer to the bibliography at the end of this report.

4.1.1 Introduction

The history of energy production indicates that it is an evolutionary process (1). For example, the slow but sure increase in the capacity of thermal installations -- always dependent on the principle of profitability -- supplies further proof of this evolution. If we consider the efficiency of the fuel used in conventional thermal stations, we realize that during the last ten years this efficiency has grown from 32 to 40% and should reach 46% in 1980.

Faced with this low efficiency of conversion (2), which represents a net loss of energy available from natural sources, it is natural that the engineer should seek other means and new methods, and should experiment with new transformations of energy. This is the reason why in the past ten years a new science, a new technology was born: magnetohydrodynamics (MHD). The principles of MHD were first studied in astro-physics. It is a fashionable science nowadays because of its numerous possible applications: controlled fusion, re-entry

of interplanetary vehicles, plasma engines, pumping of liquid metals, supersonic tunnels, grinding of high temperature alloys, chemical synthesis and, finally, the production of electric energy in a slightly ionized gas, (commonly called MHD).

4.1.2 Qualitative description of MHD

Evér since the time of Faraday, it has been known that when a conductor, for instance a copper wire, moves in a magnetic field, an electromotive force or voltage is induced in the wire: this is the operating principle of all electric generators. In addition, a current-carrying conductor which is placed in a magnetic field is submitted to a force which acts in a direction perpendicular to the directions of the current and the field: this is the principle of the electric motor and galvanometer. Although most of our present-day electrical equipment employs solid conductors, there is no reason why liquids or gases cannot be used (3), provided that these fluids satisfy the appropriate physical requirements of being excellent conductors of electricity with a definite direction of flow.

Because gases are excellent insulating materials under normal temperature and pressure conditions, it was decided to assist ionization by increasing temperature up to 3500° F, by burning fuel in an oxygen atmosphere and sealing it with an alkaline metal. In this way, high-

temperature energy conversion is obtained, which leads to high Carnot-cycle efficiency, whereas in conventional thermal plants the highest temperatures that can be applied on turbine blades (4) are 1150° F for steam and 1700° F for gas turbines. In contrast, an MHD nozzle can support temperatures of 4000° F because it does not have any moving parts.

4.1.3 Quantitative analysis

A complete mathematical analysis of the problems of MHD and plasmas is beyond the scope of this report. Those interested may refer to the excellent work done by Professor Cambel, Director of the Gas Dynamics Laboratory of Northwestern University (1). Even a rapid perusal of this article makes one realize that MHD is, in the words of Theodore Von Karman, "a happy hunting ground for scientists."

4.1.4 Present state of research

Several laboratories, including AVCO in the United States, EDF in France and CEGB in Great Britain, have set up open-cycle installations on a semi-industrial scale, for the study of the most important engineering problems presented by construction of an MHD converter, that is to say essentially:

- MHD burner and nozzle technology:

- Cooling techniques for nozzle and burner walls·
- Heat exchanger problems;
- Recycling of ionizing seed.

The AVCO group was the only one to obtain some solution to all the problems listed. They were the first to work on a semi-industrial scale. Their test facilities include burner fluid supplies, fume dilution blocks, cooling-water circuits, a load resistance block, telemetering and remote control installations, electric supply by means of a 3000 kVA transformer and rectifiers, and a nozzle-testing section equipped with an electro-magnet able to supply 30,000 gauss in an air-gap 20 inches wide and 50 inches long.

However, most of the foregoing laboratories interested in the construction of permanent electric power stations are withdrawing from this field at the end of 1969. The basic reason is that the problem of the nozzle material is far from being solved and is not likely to be solved before 1980. In any case, by that date, the fuel used in MHD technology will be required by the petrochemical industry which is developing rapidly. This last reason seems to have been the deciding factor in the decision to withdraw from this field of research.

4.2.0 Nuclear energy

4.2.1 Introduction

This section on nuclear conversion does not imply that we intend duplicating the work of Atomic Energy of Canada Limited, but simply to indicate the state of research in the world. Naturally, cooperation with AECL is still necessary to the solution of generation problems.

4.2.2 Description of nuclear fission

In a nuclear reactor or atomic pile certain heavy elements such as uranium 235, plutonium or uranium 233 undergo a transformation in which each nucleus of the element is split into two lighter nuclei of a completely different nature. This transformation, called "fission", is initiated by an incident particle called a neutron which causes emission of several other neutrons, making it a chain reaction that releases energy.

4.2.3 State of research

The word "pile", as in the case of an electrical pile (or battery) suggests a stacking of material. To create favorable conditions for large-scale fission, it is necessary to stack, according to a certain pattern, large quantities of fuel measured in tons when it is natural uranium and in kilograms when it is enriched fuel. In an atomic bomb,

fission reaction is explosive and produces a large, almost instantaneous release of heat. In an atomic reactor, on the other hand, the fission reaction is carefully controlled by materials that absorb the excess neutrons; the heat energy released is recovered by cooling the reactor. Materials called "moderators" control the speed of the fission reaction and account for a large part of the pile in ordinary thermal reactors.

Other reactors called "fast reactors" use very little moderating material. It is estimated that the average energy of neutrons producing fission in fast reactors is between 50 keV and 500 keV, whereas in conventional thermal reactors this reaction is produced by neutrons whose energy is 0.25 eV (thermal band). Because of the high energy level of the neutrons in a fast reactor, the fission of fertile material such as U_{238} is greater and, furthermore, the excess neutrons may convert the fertile materials into fissile matter. Thus, these reactors reproduce fissile matter and seem to be an inexhaustible source of energy. Even conventional thermal reactors can be modified, by means of well-known technology, to utilize the Th-U_{233} cycle. These reactors would not reproduce fissile matter but would use enough thorium to become a very large source of energy.

Canada has enough natural-uranium mineral reserves to provide

nuclear fuel for several decades. In the United States and Europe the situation is quite different. A report to the U.S. president by the U.S. Atomic Energy Commission (8) and work done by J.R. Dietrich (9) indicate that even if the fast-breeder reactor program goes according to plan it will be necessary between 1963 and 2030 to mine 1.1 million tons of uranium to meet nuclear fuel needs. This quantity is 1.7 times greater than the total quantity of uranium that could be obtained at a cost of \$5 to \$10 per pound of U_{238}. If the breeder reactors do not reach the expected level of development, the quantity of uranium required would be 4.8 million tons. This indicates that the work on fast reactors is an economic necessity for the United States and for many European countries.

Conventional thermal reactors are now used on a regular basis. Large installations exist and the results obtained lead to new projects. Each of these new projects is a further improvement in nuclear technology. Research on materials and techniques has already produced many solutions to technical problems.

Fast reactors are at the industrial prototype stage. English researchers plan to build a first prototype by 1970 or 1971 and the Americans plan on having two or three installations with a capacity

of 400 to 700 MW by 1975. Determination of the best kind of Pu-U fuel and the need to test it may delay approval of a prototype. The funds required amount to several hundred million dollars, which explains why international cooperation exists in this field. Two 25 MW reactors are already in operation in France and Great Britain.

4.3.0 Controlled fusion

4.3.1 Introduction

The basis for the study of fusion is the desire to reproduce in the laboratory the reactions that produce energy in the stars. The same principle is applied to the hydrogen bomb. The nuclear reactions just described release energy by splitting heavy atoms, whereas fusion supplies far greater energy by fusing together light atoms at very high temperatures.

4.3.2 Description

In 1932, Cockroft and Walton (10) demonstrated that the formation of heavier elements through the union of lighter atoms was accompanied by the release of energy. The quantities of energy released were finally measured by Rutherford's group in 1935 (11), the fusion of two atoms of deuterium having released 3.25 MeV. In this reaction, approximately

one thousandth of the mass was transformed into energy, which means that this kind of conversion is l million times more powerful than the burning of coal. Rose indicates that the quantity of deuterium in the world is 10^{17} pounds, and that fusion would be a source of energy greater than 10^{12} times the total energy produced in the world in 1963 (10).

A gain of energy cannot be obtained unless the speed of the electrons is comparable to the speed of the tritium ions which means that the reaction cannot take place if the gas is not completely ionized, that is, if it is not at a very high temperature of several million degrees. Therefore, the problems of thermo-nuclear fusion are the production of a confined plasma and the generation of sufficient heat. The extremely high temperatures do not permit the use of any known material for the walls, but the walls may be replaced by the action of magnetic fields produced by currents from the plasmas or from outside sources. Recent work leads to the conclusion that it is possible to obtain a stable plasma.

4.3.3 State of research

Everywhere in the world there are research groups at work on fusion. The main problem is to obtain the result: $n \times T = 10^{14}$

for the deuterium-deuterium reaction, n being the plasma ion density and T the time of confinement.

For the deuterium-tritium reaction, which is the most attractive, some laboratories have managed to reach 10^{11} and it seems that this exponent has been increased by one unit per year for the last six years.

Research teams in the world are at present:

	Personnel Number of employees	Operating budget Millions of $
United States	500	40 or more
Free World (excluding the U.S.)	680	40 or more
U.S.S.R.	600	--

Although the final results of thermo-fusion research are still far in the future, the work accomplished to date has enabled us to perfect our knowledge in many fields of technology such as super-conductors, the creation of high vacuums and the study of high temperatures. New measuring procedures have also been devised which find useful application in many other areas, especially in the study of electric arcs.

4.3.4 Future of controlled fusion

Considering the present state of research, it seems possible that a zero-energy fusion reactor might be made to operate between 1970 and

1980 (12). The technological problems for this type of reactor are so great, however, that fusion reactors are not expected to reach a level of development comparable with today's thermo-nuclear reactors until 1990. Fusion has not as yet shown any great economic advantages over fission, but it must be kept in mind that fissile materials are not inexhaustible and, what is more important, fusion emits very little radioactivity and requires a smaller operating staff. In any case, we must push ahead with research now if we are to obtain reactors of this type by the year 2000.

4.4.0 Thermoelements and thermodiodes

It is not foreseen that research on thermoelements and thermodiodes will lead to the construction of profitable new types of power stations. But special applications of these devices are useful.

4.5.0 Fuel cells

4.5.1 General characteristics

At the present time electrical energy needed in remote regions of Quebec and Canada is generally supplied by independent generating units. The high cost of electricity from such units (19.5 cents per kilowatthour) is due especially to high operating and maintenance costs. One

of the problems confronting public utilities is the replacement of these costly units by another type of electrical generator that is as durable and reliable, but cheaper to install and operate. The fuel cell may be the answer to this problem and Hydro-Quebec has embarked on an evaluation program which, after three years of research, should result in a prototype that can be quickly put into manufacture.

Although this evaluation is not yet finished, it is now clear to us that there are problems concerning the materials used as catalysts in electro-chemical reactions. To achieve a low overall unit cost for fuel-cell systems, cheap catalysts must be used. This excludes noble metals and their alloys. In addition to being cheap, the catalyst material must be durable and reliable under the operating conditions of the cell (temperature, pH of the electrolyte, etc.). To date, the most interesting type of cell is the hydrocarbon-air cell which uses an acid medium when it is a low-temperature cell. For this system, problems associated with the materials remain untouched. The hydrogen-air cell is simpler, and we are of the opinion that more research should be done on the cathode materials for the air electrode. A successful program of research on such materials requires considerable equipment

and personnel and may be more than one laboratory can cope with. We believe that well-planned and coordinated activity can be effective in this field. This means that the program's aims, schedule, division of tasks and the final benefits for each participant must be clearly laid down. If manufacturers are involved, the problem of industrial ownership is vital.

It is worth noting that IREQ's proposed studies of fuel-cell materials for particular applications could lead to other applications, for example, fuel cells for vehicles, for telecommunications, etc. Each application would require a special study of the particular system.

Hydro-Quebec's role as an electrical utility has given it an interest in other systems of electrochemical conversion. Specifically, an original program of research on batteries will be launched in order to explore the possibilities of making completely solid batteries by the successive stacking of very thin electrode-electrolyte-electrode elements. This system could lead to the development of high-output batteries with a high power-to-mass ratio.

By evaluating a possible fuel-cell program to answer a particular need, IREQ has become interested in means of conversion that could be competitive, and a program of this type may be launched later on.

4.5.2 Cost of research

Even though the total amount spent annually in the world for fuel-cell research is more than $60 million, there are seldom more than 20 researchers per laboratory engaged in this work. A serious effort in this field would require the following staff, space and budget:

	Space		Instrumentation	Personnel		Operating
	sq. ft.	$		Researchers	Aux.	cost
Chemical problems	8,000	160,000	$150,000	6	8	$200,000
Problems of materials	4,000	80,000	$100,000	4	5	$100,000

Making a prototype ready for industrial production might require double these amounts.

4.6.0 Conventional methods of conversion: thermal power stations, motors and gas turbines

4.6.1 Introduction

The development of new and revolutionary energy conversion methods spurred more research in the conventional systems. It may even be said that the manufacturers of thermal plants and gas turbines have advantageously utilized new materials and new techniques produced by MHD and nuclear research. An appreciable increase in efficiency and greater flexibility of operation have resulted.

4.6.2 Research

Turbogenerators are under constant study in many laboratories throughout the world. Intensive studies are being conducted with the purpose of reducing the cost of manufacture through the use of liquid metals (generally sodium) to carry heat to the turbine, reheaters and superheaters (14), (15). Liquid metals have a high heat-exchange coefficient which helps reduce pressures and makes possible the use of thinner walls and less expensive alloys for the pressure tubes. As a result, the turbine-reheater-superheater unit would occupy much less space, with a consequent investment saving of up to 20% (especially if an additional reheater is added). Efficiency can be further increased by choosing two liquids and using each at the temperature range where its heat-exchange properties are at their best.

Some industries are even considering the manufacture of integrated units comprising turbine, generator and transformers. By cooling the conductors with liquid hydrogen, it is expected that costs and size can be reduced. Buscemi of Westinghouse proposed the use of thermal plants combined with gas turbines to achieve an increase in efficiency of up to 6% (16). This cycle has been studied for natural-gas installations only, and not for mixed-fuel plants (coal - gas). Gas

turbines have very low thermal efficiency and will only find application in medium-size plants or as a source of peak power. Laboratory costs are similar to those for MHD.

4.7.0 Conventional methods of conversion: hydraulic turbines

4.7.1 Hydraulic power stations

Hydraulic power stations offer the great advantage of using a low-cost fuel. However, studies have indicated that in the U.S., nuclear plants will be more economical by 1975, even using 700-kV transmission lines, if the distance between the load centre and the hydraulic source is more than 450 miles and if the cost of construction cannot be reduced to less than $250 per kilowatt (17), (18). It becomes obvious, then, that hydraulic plants must be further improved if they are to remain competitive.

There are great numbers of small rivers with low heads which could be harnessed to supply small quantities of power. These small plants could cover a range of heads from 3 to 25 feet, and yield anywhere from a few dozen to a few hundred kilowatts. Intensive studies have been carried out in Europe on the conditions for the profitable

operation of such developments, and it has been found that bulb-type turbines can be used in a number of ways -- in a throat, a conduit or a siphon, the latter being the most advantageous. EDF has studied 19 small plants, of which several are already in operation. Some of these plants are asynchronous and others are synchronous (19).

4.7.2 Research

Hydraulic studies of this kind are made in laboratories identical to the Chatou Research and Test Centre. The installations are ordinarily divided into three sectors: the first is devoted to testing and research on reduced-scale turbines, which enables the technical characteristics to be determined under excellent conditions and experiments to be carried out on new models; the second contains reduced-scale powerhouses and hydraulic developments for the study and testing of models; the third is a field division in charge of determining the correlation between scale-models and full-size installations.

The personnel, equipment and testing apparatus required depend on the work to be done, but it may be said that each sector needs at least four researchers and six technicians. Investment necessary for each of the first two sectors is about $250,000 and operating expenditures exceed $150,000 per year.

In all hydraulics laboratories, work is done not only on hydroelectric developments, but also on maritime, river and general hydraulics. Canada already has many hydraulics laboratories and Hydro-Quebec is of the opinion that at present it is mainly a matter of coordinating the efforts of researchers in this field.

More recently, some laboratories have been able to conduct studies on the problems of fluid flows in thermal and nuclear stations.

4.7.3 Prospects

There is no doubt that in the future all important hydroelectric sites will be developed because their "fuel" renews itself easily, operation is reliable, and hydraulic power stations do not pollute the air or the water. In addition, the flexibility of adaptation to load changes and peak demands constitute important factors in their favour (20).

4.8.0 Electrical laboratories

4.8.1 Introduction

Independently of new methods of electricity production, the problems of energy transmission and distribution will always be present. The European laboratories are far more advanced than American laboratories in these fields of research.

4.8.2 Research

Electricity problems studied in laboratories can be classified in two categories:

4.8.2.1 Research and development problems

1. Intensive studies must be conducted on the electric arc to contribute to a reduction in the manufacturing costs of electrical equipment. Every possibility should be analyzed, particularly those offered by vacuum, air, hexafluoride and other kinds of switches. Further research should be done on the use of liquids and semi-conductors.

2. A complete evaluation of existing insulating materials should be undertaken, as well as the synthesis of new types for cables and high-voltage transmission lines.

3. High-voltage corona effects and radio interference, as well as the action of lightning arresters in dry and wet conditions are not sufficiently well known in either a.c. or d.c. systems.

4. New methods must be found to measure electrical quantities (current, voltages, etc.), otherwise we will be forced to build even larger potential and current transformers.

5. The application of cryogenics and superconductors to the problems of electrical transmission and distribution within cities may become more feasible.

6. The use of solid-state devices in the manufacture of relays and metering instruments is becoming more necessary.

7. Synthetic measuring methods must be developed.

8. D.C. transmission phenomena should be evaluated.

9. Specialized automatic controls will be necessary for the operation of future systems.

10. The action of grounding devices and ground currents, especially under high-voltage transmission lines, is scarcely known.

11. The study of new methods of storing electrical energy would greatly help in solving the problem of peak loads.

Although incomplete, this list gives an idea of the problems that should be studied in laboratories.

4.8.2.2 Testing and control problems

Testing and control work may be focussed on breakers, lightning arresters, fuses, transformers, insulated or non-insulated conductors, and so on. Such studies aid in the accumulation of useful information for the adootion and evaluation of standards and for the checking of other studies.

4.8.2.3 Instrumentation

The following table indicates the short-circuit interrupting capacities of existing laboratories:

Laboratory	Source of power	Short-circuit MVA	Synthetic MVA
CESI	Transformers	6000	14,000
Fontenay	"	5000	
Westinghouse	Rotating machines	4000	
KEMA	"	3700	
ASEA	"	3500	
General Electric (Philadelphia)	"	3250	70,000
Brown Boveri	"	4000	

In this table we have assumed symmetrical currents and single-phase tests but we have indicated the equivalent three-phase MVA's.

The creation of an institute to tackle these problems requires an investment that could exceed $25,000,000. (21). With a staff of 200 researchers and technicians, the operating budget would be about $3,000,000.

4.9.0 Electronics: Control systems and communications

4.9.1 Introduction

In mentioning electronics as a subiect for research or testing, we do not mean to imply the development of new tubes or transistors. We are thinking rather of using existing elements to solve problems of communications, automatic control and system automation.

4.9.2 Research

4.9.2.1 Control systems

Automatic control of a powerhouse or network presents enormous problems of metering and the evaluation of existing equipment. For a manufacturer to be able to supply the re-

quired electronic equipment, he must be given detailed specifications and only the electrical utility itself is in a position to analyze the problem systematically. The laboratory may also help in the study of the elements in the automation sequence (regulation, controls, metering). Its investigations cover all electrical, mechanical, hydraulic and pneumatic devices such as transducers, comparators, amplifiers, motors, etc. Some sub-assemblies of the automation sequence may be tested before final installation by means of analog computers or mechanical or electrical simulators that replace full-scale equipment. Such testing equipment is extremely valuable in determining the optimum composition of automation sequences.

A laboratory of this type would be used to study all the new control problems that will arise with the construction of nuclear power stations. Its role would be to determine the transfer functions of the new installations in order to avoid any instability under operating conditions. It could help in the choice of the best controls which would meet the needs of the new installation and at the same time integrate it properly into the existing network.

4.9.2.2 Communications

The problem of transmitting information is of major importance in the economic operation of a network. Forecasts indicate a substantial increase in the number of channels that will be required in the future. Systematic studies of new developments in electronics will enable the establishment right now of communication methods that can be adapted to all future circumstances.

The laboratory team could also study the metering problems and instrumentation requirements for maintenance, and help in obtaining the necessary equipment. In all research laboratories, a group of electronics experts is absolutely essential because all metering today involves electronics.

5.0 CHOICE OF RESEARCH PROGRAMS

5.1.0 General

The need to establish a program can be better understood if one gives thought to the statement of C. Wilson Randle in the January 1959 issue of the Harvard Business Review: "... all available evidence points to a heavy mortality in research projects. For example, the average experience of 20

companies in the chemical industry shows that one successful product results from every eight projects that go into research. Similar situations seem to be present in all industry. Survey results covering more than 100 major companies show the median failure to be about 67%."

The main causes of failure are studied by Edward B. Roberts in his book "The Dynamics of Research and Development." Causes are found mainly in the organization of research within isolated compartments, in the overestimation of secondary problems and, finally, in the exaggerated importance given to certain badly chosen subjects.

The compartmentalization of research enables each group to study its own "special little problems" but masks the elements of interdependence. It facilitates management of the centre but also raises almost insurmountable barriers that prevent one from viewing the organization as a whole. The secondary problems have led the management of several centres to choose methods that give rapid results: the good salesman replaced enlightened management and the artificial solution replaced the really deep study. The false attitude in tackling problems resulted in the fragmenting of research problems to the point where all efforts were directed to maintaining liaison and the problem itself was lost sight of. A single research project

was divided into seven or twelve sub-projects without a common link and often without coordination. Consequently, the main problem was forgotten and in one case, the budget was exceeded by 1176%!

An organization's research program should avoid these pitfalls by requiring the active participation of everyone. Study of the problems and the subjects recommended for research should emanate in large part from the operating personnel, not only at the start but continually from then on. The operating engineers are deeply aware of the problems and the costs involved. The research engineer will analyze the problem. If a theoretical study of the subject indicates a solution, he will submit it for approval; if not, he should suggest a method of tackling the problem and keep the engineer informed of the progress of his work. This will eliminate the danger of exploring attractive areas that are not directly related to the subject.

One criterion in hiring research workers will be to build team spirit. Physicists, mathematicians, engineers and other specialists may be required but, right form the start, they must be oriented towards one or several major ideas.

5.2.0 Program

Before making a definite choice of the research program to be followed, the Commission called on research experts from universities, industry and public utilities in order to analyze the recommendations of its own committee.

A study of the problems of Canadian electrical utilities and manufacturers led this committee to recommend the establishment of a high-voltage laboratory and a high-power laboratory in order to meet the needs of electrical research, not only for Canada but for the whole of North America. In addition, this high-power laboratory will have a short-circuit capacity (and associated instrumentation) greater than that of any existing laboratory.

In order to enable the Institute to fulfill its role as a research centre, it was decided that, in addition to the laboratories already mentioned, general or "light" laboratories would be set up with researchers from all the technical disciplines working in teams.

To further emphasize the necessity for team work, all industrial research centres have based their organization charts on the projects themselves. The old type of organization, based on electrical, mechanical

and civil engineering, metallurgy, chemistry, physics, etc., has disappeared almost entirely in large modern research centres. A project involves all the disciplines but the various talents must be coordinated. For example, the study of a new type of high-voltage apparatus requires not only electrical engineers, but also physicists, mathematicians, metallurgists, chemists, physical chemists, architects and economists because the problems involved demand a good knowledge of materials, calculation methods, the action of fields on matter, mechanics, methods of cost projection, marketing, etc. Today, any research program requires men of vision and extremely wide knowledge.

5.2.1 General laboratories

The general laboratories will house a group of more than 75 career scientists, comprising mathematicians, physicists, chemists and mechanical, electrical and metallurgical engineers who will form teams for each particular project. The nucleus of the research staff will be lodged in the General Laboratories building to insure maximum liaison and support for the High Power and High Voltage Laboratories.

These specialists will be able to fill the gap between research and the development of materials, on the one hand, and research and development concerning the application of these materials to electrical equip-

ment, on the other hand. The study of materials will be carried out by a separate, well-equipped research group. In addition, a basic-sciences group will seek better knowledge of electric arcs and will keep up to date with world-wide developments in plasmas and thermofusion.

A team of electrochemists will evaluate the potentialities of fuel cells to meet the electricity needs of remote regions.

Specialists in vibration and thermodynamics will study the present problems of transmission-line structural members and vibrations, as well as the problems associated with heat exchangers in nuclear and thermal power stations. A group of mathematicians will seek solutions to the numerous problems of networks and will make available to Canadian public utilities a computation centre to meet their needs. At present, Canada depends entirely on American centres for these solutions.

Finally, a laboratory will investigate problems of system automation by studying control systems and the transmission of information in order to lower operating costs, either for remote control or metering.

5.2.2 Physical installations and equipment

5.2.2.1 Site

Hydro-Quebec's Institute of Research is located 18 miles

southeast of Montreal, near the 735 kV Boucherville substation, thus enabling tests to utilize the short-circuit capacity of an extremely powerful electrical network.

This strategic site meets our needs and is readily accessible by all means of transportation. An International Airport is only 40 miles away.

5.2.2.2 Laboratories and staff

As indicated previously, IREQ comprises three main sections, each quite flexible: the High Voltage laboratory, the High Power laboratory and the General Laboratories. We are convinced that the Institute will satisfy in large measure the needs of Canadian enterprises in the fields of electrical research and testing at all currents and voltages. All our staff of approximately 200 scientists and technicians will be able to fulfill a great many requests for studies and research and to help engineers keep abreast of technological developments through training in our laboratories.

5.2.2.2.1 General laboratories

Construction of the General Laboratories building, which will also house administrative services, will be completed in 1969. The main building will also contain an

auditorium, library, cafeteria, mechanical workshop and all the installations needed by the research staff. The High Voltage laboratory will be finished at the end of 1970 as well as part of the High Power laboratory. All construction will be completed at the beginning of 1972.

Scientists working in the General Laboratories will include mathematicians, physicists, chemists and mechanical, electrical and metallurgical engineers as well as other specialists who will join research groups for each particular project.

At present, few important problems are resolved by individuals working alone. For this reason we will form research teams for each major project, made up of specialists in the various disciplines and often the client's staff.

5.2.2.2.2 Scope of research and tests

The laboratories will have complete installations for studying and testing all power transmission and distribution equipment.

Intensive studies will be undertaken to reduce equipment costs. All possibilities will be investigated including the use of new materials.

All the research staff will be housed in the same building to ensure maximum liaison.

Researchers will carry out intensive studies into the problems of the highest voltages attainable. Special care will be devoted to high-voltage, direct-current transmission lines and terminal equipment.

The High Voltage laboratory will also be used for development and acceptance tests of equipment for all systems at voltages up to the highest attainable.

We believe, however, that one of the functions of the High Voltage laboratory will be to study acceptance-test standards with a view to simplifying them. The same service will be provided by the High Power laboratory.

The High Power laboratory will be used for research and testing of equipment at present and future a.c. and d.c. power levels. The present capacity of the

Hydro-Quebec system will be multiplied five times by synthetic testing methods. The range of voltages available will enable tests to be carried out according to C.S.A., U.S.A.S.I. and I.E.C. standards. The Institute of Research will be able to study all the problems mentioned in paragraph 3.8.2.1.

5.2.2.3 High Voltage Laboratory

The dimensions of the hall, its shape, equipment-handling and transport devices, type and capacity of test equipment, etc. were carefully studied in consultation with international experts. Our choice was based on future utilization and the cost of the installation.

One of the basic principles in our planning was flexibility. For example, several high voltage laboratories have only stationary test equipment and fixed test zones.

The Institute decided on complete mobility of equipment. The savings in construction of the hall will greatly exceed the increased cost of mobile equipment.

High Voltage hall and its annex

The High Voltage hall will have a floor area of 270' x 220'

and a free height of 160'. These dimensions were determined after careful study of future system and test voltages, which also included experiments carried out by CESI, Milan, to verify necessary insulation clearances. The dimensions chosen will permit acceptance testing and research on heavy equipment for future 1100 kV systems, with a safety margin of 25%. However, an increase in the height of the hall beyond that required for 1100 kV equipment has been made to permit acceptance testing and research on most 1500 kV equipment. The remaining 1500 kV equipment will be tested in an outdoor test area adjacent to the hall.

The hall will be divided into three independent test areas, each with its own control room. Only in the case of tests at the highest voltages will all non-essential equipment be moved back to the walls to permit one test to be carried out at a time.

Adjacent to the hall and accessible by a gate, 65' x 65', will be an annex containing offices, one large room and several small areas for erection and various types of tests, a corona test chamber, a test chamber for artificial pollution and a hall for rotating machinery. Bushings in the annex roof will permit direct connection

to the 735 kV three-phase or 1500 kV single-phase lines from the High Power laboratory. These facilities will permit testing required by international standards or by new standards to be established by the laboratory. In addition to an outside area for general testing purposes, there will be an insulator test rack for studies regarding natural pollution at high a.c. and d.c. voltages. There will also be at least one a.c. and one d.c. test line to carry out measurements to determine the best characteristics of transmission lines.

Equipment

The planning of the equipment has involved frequent contacts with certain manufacturers and at present, definite specifications in this regard are being prepared. Following is a list of the main items:

- One 6.4 MV, 400 kWs impulse generator.
- One 3.2 MV, 200 kWs impulse generator which can be increased to 400 kWs.
- Three cascade transformer units, each rated 750 kV rms, 2.0 amp. When cascaded, 1.0 amp. at 2.1 MV will be available continuously while 2.5 amp. will be available for 10 minutes.

- Two cascade rectifiers, each rated 1.2 MV, 50 mA. Special connections will permit the supply of 200 mA continuously from the paralleled rectifiers.
- Voltage dividers for the above equipment.
- One tank to be used for oil, vacuum, and heat treatment, and for dielectric tests on models. The volume of the tank will be about 40,000 gallons.
- Rotating machinery up to 5 MVA, with variable frequency; and several other machines.

All the equipment, except the rotating machinery, will be mobile.

5.2.2.4 High Power laboratory

Power available

The power required by the High Power laboratory will be supplied by three high-voltage lines at 230, 315 and 735 kV from the Boucherville station located one mile from the Institute.

The high short-circuit capacity of the Boucherville station will make the following power available for routine testing in the test bays without causing intolerable disturbances to the Hydro-Quebec system:

5,200 MVA (3-phase) and 4,000 MVA (2-phase) in 1972

7,800 MVA (3-phase) and 6,000 MVA (2-phase) after 1980.

Greater MVA capacity will sometimes be available at 230, 315 and 735 kV.

We will also be able to do closing and reclosing tests at 315 and 735 kV on lines in service varying in length from one mile to 300 miles. These connections to the network are shown on the attached single-line diagram. For tests requiring less power, a disturbable 24 kV auxiliary network will be used so that other tests can be carried out simultaneously using the large transformers.

Description of the three main sections of the High Power laboratory

As shown on the basic diagram, the laboratory is divided into three main sections. The first will be used for tests on 2 kV to 72 kV industrial and power-distribution equipment. Test power up to 500 MVA will be provided by a special transformer. Voltages will be variable from 2 kV to 25 kV in 1% steps, using a series auto-transformer. Three-phase tests will be possible up to 6,000 MVA (3-phase) using six 1,200 MVA transformers at voltages varying from 8 kV to 72 kV. Four test cells (6 x 6 x 8 meters) will be available in this section, arranged so as to enable our clients to keep their work confidential.

The second section will be used to study and test electrical apparatus at voltages from 72 kV to 765 kV (3-phase) and eventually 850 kV phase-to-ground. This section will include a synthetic-test bank having a recovery voltage close to 1200 kV, enabling the abovementioned power source (2-phase) to be multiplied by an average factor of 6, thus giving a three-phase equivalent of 60,000 MVA. Two enclosed cells, 70' x 100' x 70', will be able to house one complete 765 kV pole or one three-phase 315 kV circuit breaker. A third cell for 1100 kV to 1500 kV equipment will be built later. The facilities will allow us to study mercury valves and solid-state rectifiers that will be used on d.c. systems. An open-air cell will also be available for tests on insulator strings and lightning arresters. A three-phase line between the High Voltage laboratory and the High Power laboratory will greatly increase the possibilities for temperature-rise and voltage tests on transformers and reactors.

The third section will be used for very high current tests up to 500 kA. We will then be able to study I^2R losses and mechanical forces on busbars and conductors. Low-voltage equipment of 110 to 1000 volts will also be studied and tested in this section. A direct-current laboratory with a capacity of about 4000 kW and voltages varying from 600 to 4000 volts will also be available.

Major equipment:

Transformers

1. Six (6) transformers

short-circuit capacity: 1200 MVA

primary: 425 kV

secondary: 4 windings, 25 kV

4 windings, 2.5 kV (or equivalent)

continuous power rating: 40 MVA

test voltage will be adjustable to ± 5% accuracy

2. Three (3) transformers

short-circuit capacity: 200 MVA

continuous power rating: 5 MVA

primary: 230 kV

secondary: 4 windings, 4 kV

3. Heavy-current supply transformers

primary: 25 kV

secondary: 4 windings of 400 volts

continuous current: 72,000 amp.

current (1 sec.): 500,000 amp.

Reactors

1. one 400 kV set, with $\pm$ 3% adjustment of current
2. one 25 kV and 72 kV set for medium-voltage test cells.

Capacitors

One bank of static capacitors rated 100 MVAR.

Loads

One set of loads to vary the power factor. One artificial line for kilometric fault studies; it will be capable of carrying 40 kA and will have variable impedance.

Synthetic tests

A 1500 kV source suitable for tests with two successive interruptions.

Circuit breakers

1. Voltages: 765 kV, 315 kV, 230 kV

   rupturing capacity: 25,000 MVA

2. Voltages: 25 kV, 72 kV

   rupturing capacity: 3,000 MVA

Disconnect switch and busbars

There will be disconnect switches and busbars specially designed for the high currents planned and flexibility required.

Taps on lines in service

Taps on two 315 kV and 735 kV lines in service will enable automatic reclosing tests to be done on short and long lines.

Lengths of lines: 1, 10, 145 and 260 miles.

5.3.0 Cost of the Institute

In October 1964, the Commission made available to its Institute of Research a total budget of $500,000 for preliminary studies.

5.3.1 Capital budget

Engineering and architectural work	$2,000,000
Preparation of site:	1,827,000
Construction	
General laboratories and equipment:	5,521,000
High Power laboratory:	14,551,000
High Voltage laboratory:	10,400,000
Workshops and equipment:	404,000
TOTAL:	$34,703,000

5.3.2 Proposed operating budget

Depreciation		$2,099,000
Wages and salaries:		1,938,000
Sundries		385,000
	TOTAL:	$4,422,000
less revenue from customers for tests:		$2,560,000
Annual deficit:		$1,862,000

BIBLIOGRAPHY

(1) Ali Bulent Cambel; Magneto-Gasdynamics: its Science and Technology; American Scientist, Vol. 50, No. 3, September 1962. Pages 375-408.

(2) M.M. Magnien: La production d'énergie électrique par voie magnéto-hydrodynamique. Page 3 dans le bulletin de la Société Française des Electriciens, janvier 1964.

(3) W. Craig Moffatt; Magnetohydrodynamic Power. Generation - Principles and Problems. Page 53 of Engineering Journal, Vol. 46, No. 5, May 1963.

(4) Jean Péricart; Difficultés et espoirs suscités par la M.H.D.; Journée de la Conversion de l'Energie, Institut Français des Combustibles et de l'Energie, février 1964 - VII-3.

(5) P. Langevin; Une formule fondamentale de théorie cinétique. Ann. de Chimie et de Physique, Ser. 8, pp 245-288, 1905.

(6) P. Langevin; La physique des électrons. Revue Générale des Sciences Pures et Appliquées, Vol. 16, pp 257-276, 1905.

(7) National Power Survey, Federal Power Commission, 1964. Part 2, pp. 73-79.

(8) A.E.C. Civilian Nuclear Power. A Report to the President, Nov. 20, 1962.

(9) J.R. Dietrich; Efficient Utilization of Nuclear Fuels; Power Reactor Technology, Vol. 6, No. 4, 1963.

(10) D.J. Rose and M. Clark; Plasma and Controlled Fusion; Wiley and Sons, N.Y., 1961.

(11) T.S. Green: Thermonuclear Power; G. Newnes Ltd., London, 1963.

(12) J.B. Adams; Can We Master the Thermonuclear Plasma; the New Scientist, Jan. 31, 1963.

(13) Proposed Research Program, Battelle Memorial Institute; Improvement in Electrochemical Reactions of Fuel-Cell Electrodes, May 21, 1965.

(14) F.A. Ritchings; Site Planning for Large Thermal Generating Stations: Proc. Amer. Power Conf. Vol. 24, 1962, pp. 338-349.

(15) Liquid Metal Handbook. Second Edition, 1962.

(16) V.P. Buscemi; Westinghouse Engineer, May 1965.

(17) J.K. Dillard and C.J. Balwin; The Economic Development of Mine-Mouth Power Plants, EHV Transmission and Nuclear Generation in the United-States; World Power Conference, Lausanne, Switzerland, Sept. 13-17, 1964.

(18) J.K. Dillard; What's Ahead in Transmission Systems; I.E.E.E. International Convention, March 23-26, 1964.

(19) F. Auray; Les microcentrales. Houille Blanche, no I, 1964, t. 19, pp 25-32.

(20) National Power Survey, Federal Power Commission, Part 1 - 1964, p. 117.

(21) Leonard J. Linde; An Opportunity for the Power Industry in Research and Development; page 130 I.E.E. Convention Record, 1964.

Appendix

CEMA

CANADIAN ELECTRICAL MANUFACTURERS ASSOCIATION

10 PRICE STREET

TORONTO 5, CANADA

TELEPHONE 927-3931

1 ? DEC 1968

December 12, 1968.

Mr. Jean-Claude Lessard,
President,
Hydro-Quebec,
75 Dorchester Blvd., West,
MONTREAL, P.Q.

Re: Hydro-Quebec Institute of Research

Dear Mr. Lessard:

The purpose of this letter is to convey to you a decision of the Board of Directors of this Association at a meeting held in Toronto on December 11th, 1968.

It is recognized by the Board that a number of CEMA member companies have expressed a need for a high voltage, high power test facility in Canada.

Accordingly, the CEMA Board of Directors is in favour of, and endorses, the construction by Hydro-Quebec of a Research Institute as it has been described.

Yours truly,

K. H. Rapsey,
President.

CANADIAN ELECTRICAL ASSOCIATION - ASSOCIATION CANADIENNE DE L'ÉLECTRICITÉ

OFFICE OF THE PRESIDENT
D. MACLAREN
MACLAREN-QUEBEC POWER CO.,
BUCKINGHAM, QUE.

TEL. 986-3345

August 15, 1968

Mr. R.A. Boyd,
General Manager,
Hydro-Quebec,
75 Dorchester Boulevard West,
Montreal, P.Q.

Re: Hydro-Quebec Research and Development Centre

Dear Mr. Boyd:

As President of the Canadian Electrical Association, it is my pleasure to officially inform you of a decision made by the CEA Board of Directors concerning the establishment of a Research and Development Centre by your utility, Hydro-Quebec.

A motion was passed, at the last meeting of the Board of Directors, stating that: "the CEA go on record as endorsing and being in favour of the Hydro-Quebec activity in the construction of a Research and Development Centre".

It was the feeling of the Board that such a research facility could be of great benefit not only to your utility, but also to the entire electrical industry of Canada. Judging by the scope of its proposed activities, the Centre promises to keep your utility and your associates in the forefront of electrical research.

I would like to assure you of the close cooperation of CEA, should you desire to involve other utilities in your research activities and also to keep them informed of the work of your Research Centre.

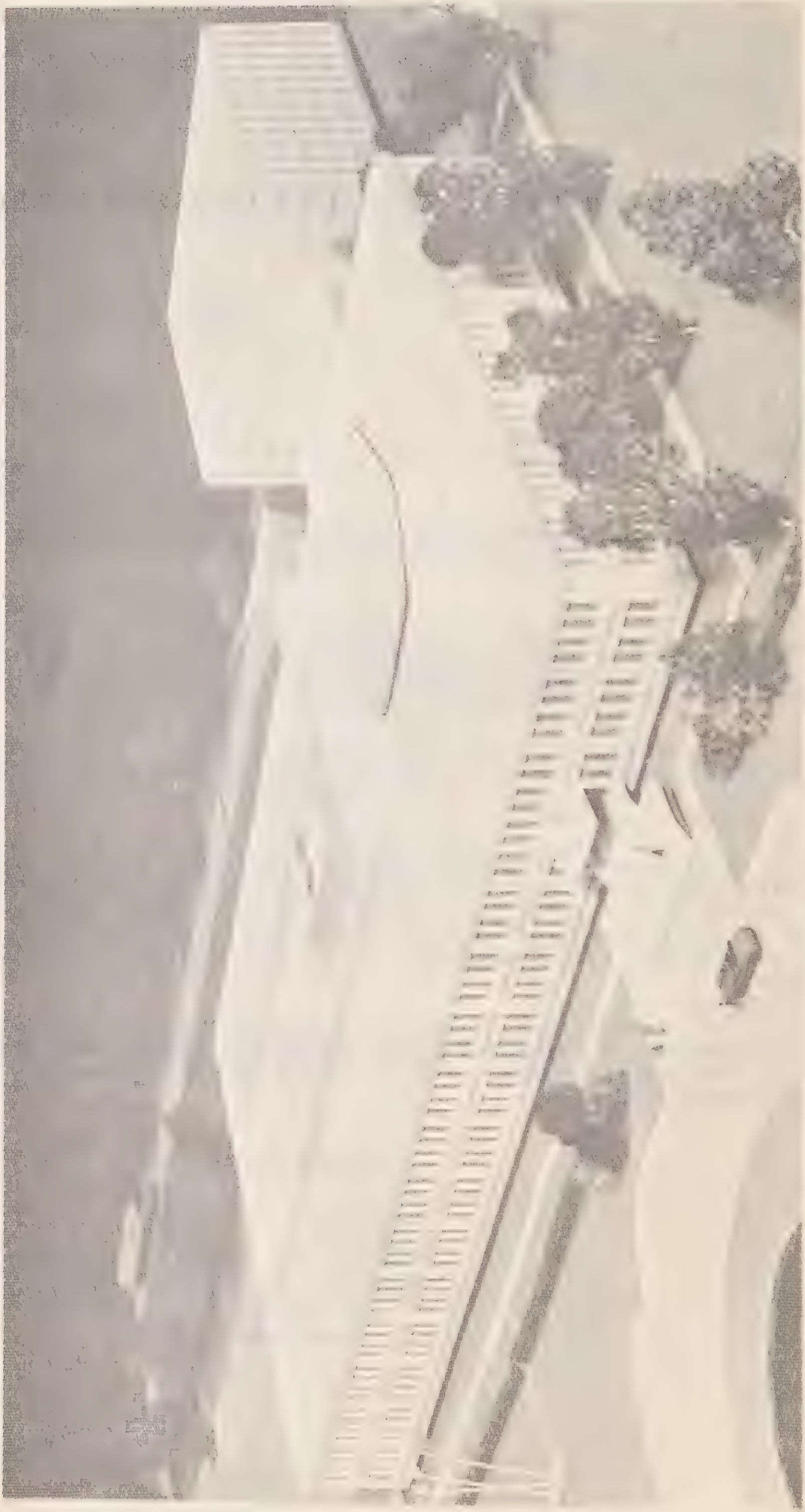
Yours truly,

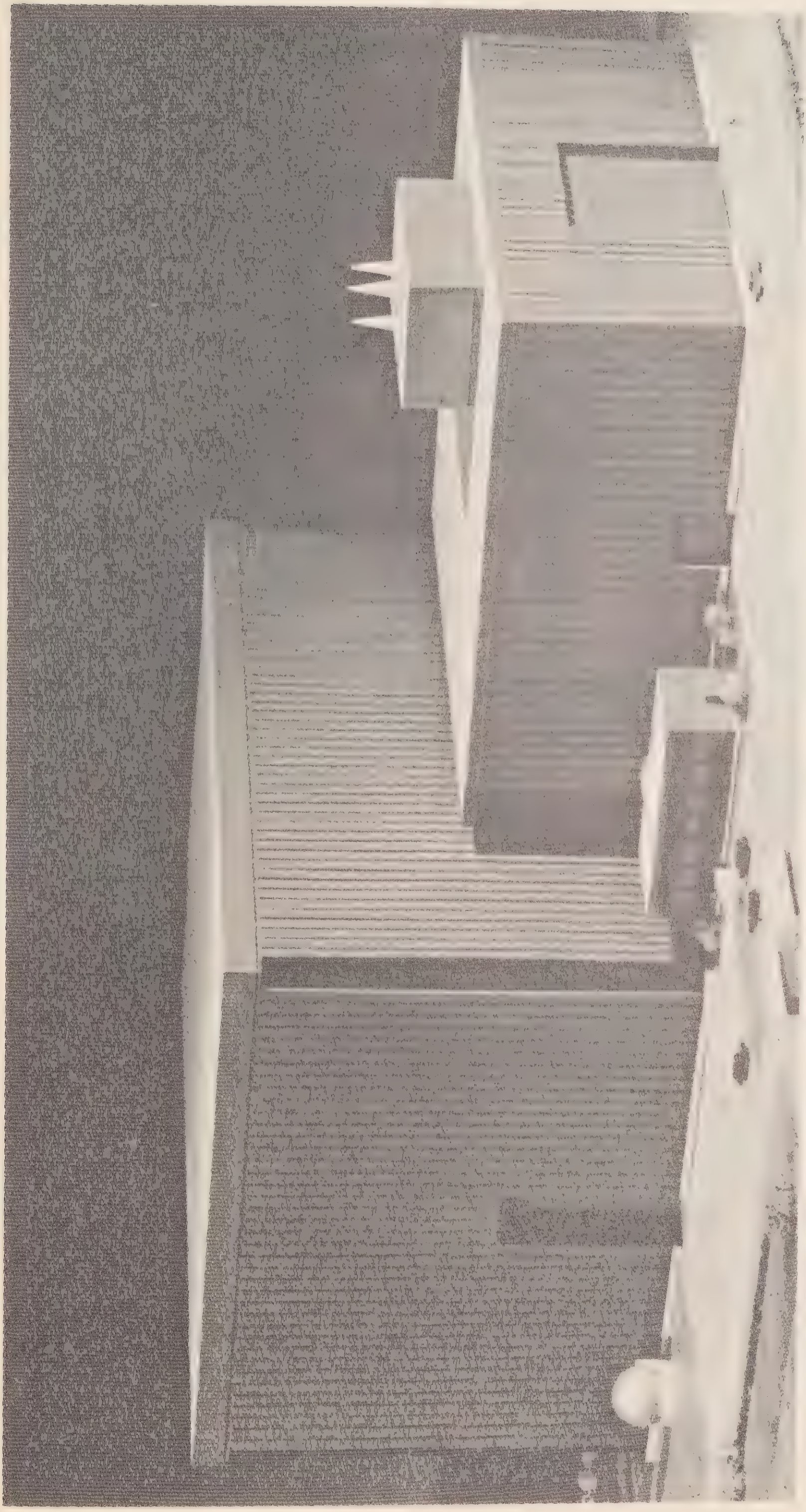
D Maclaren

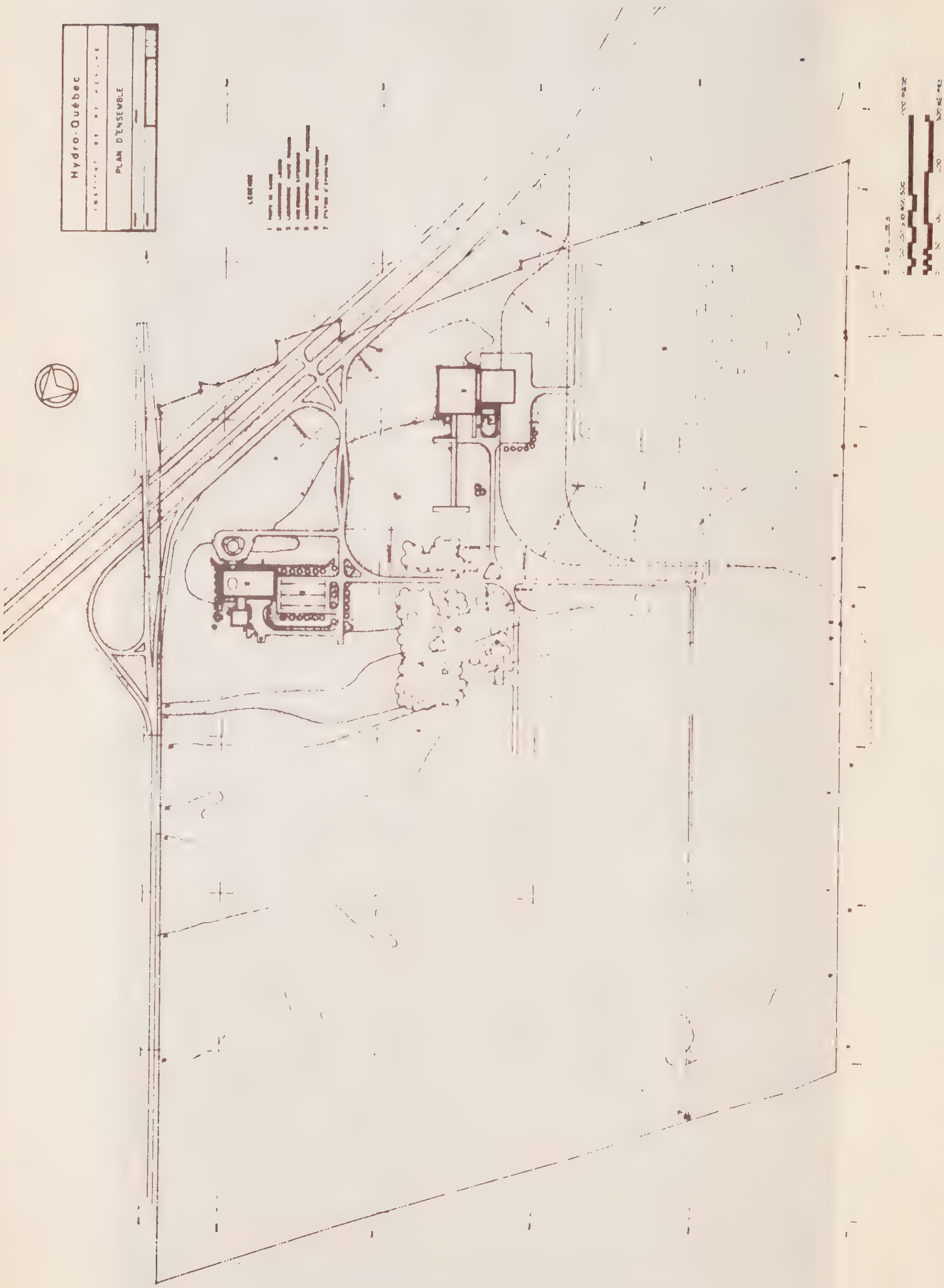
D. Maclaren,
President.

DM:ge

OCT 19 1968



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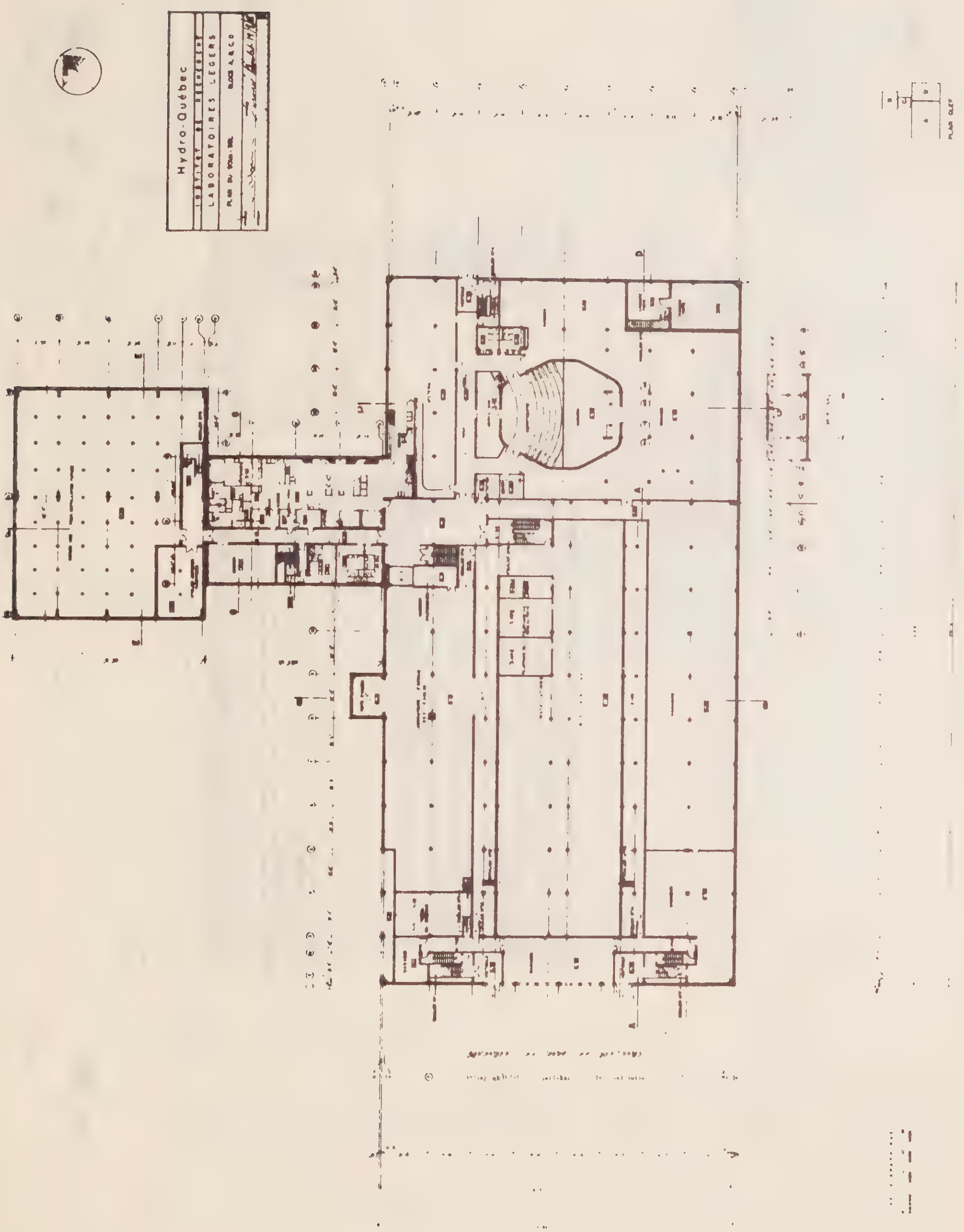
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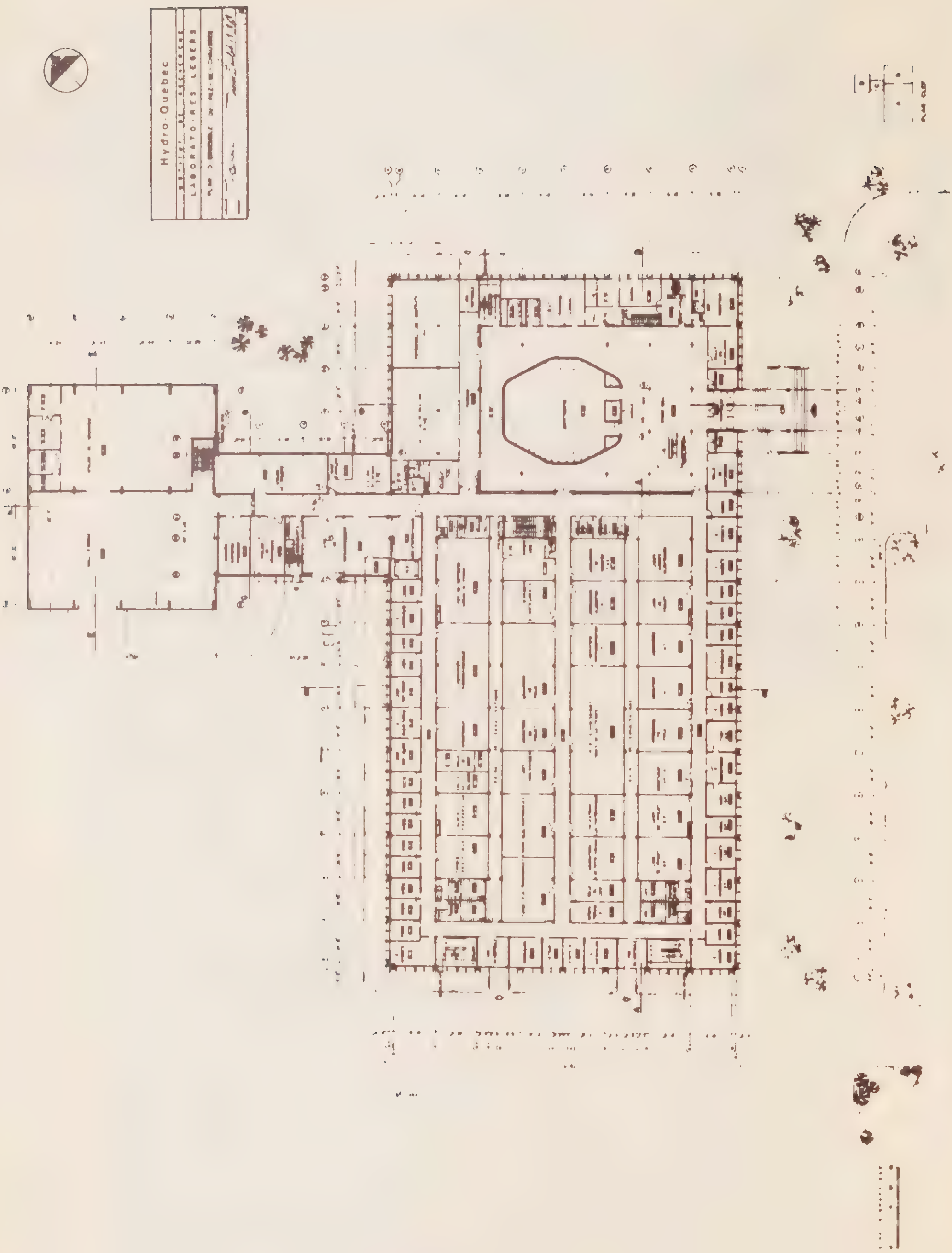
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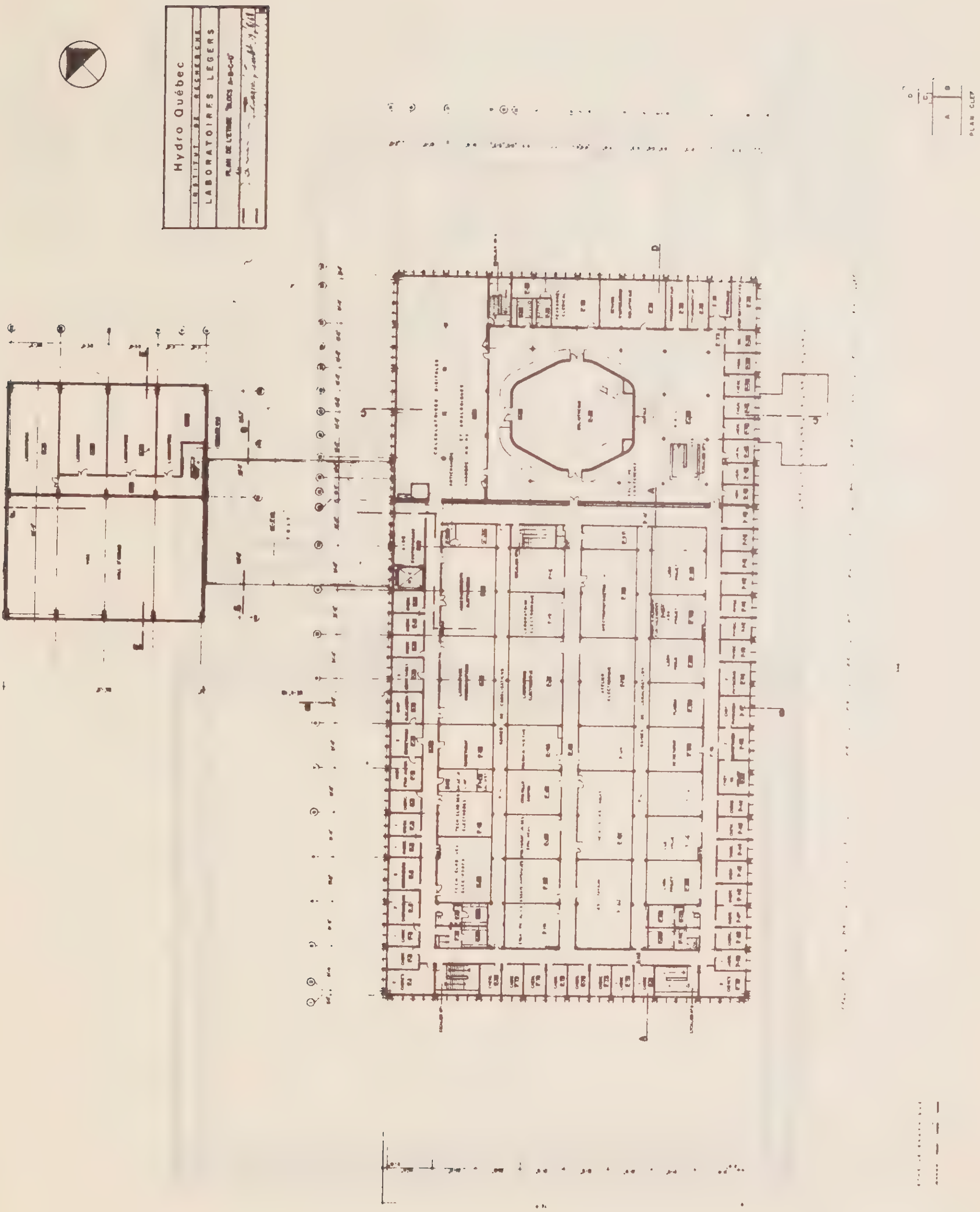
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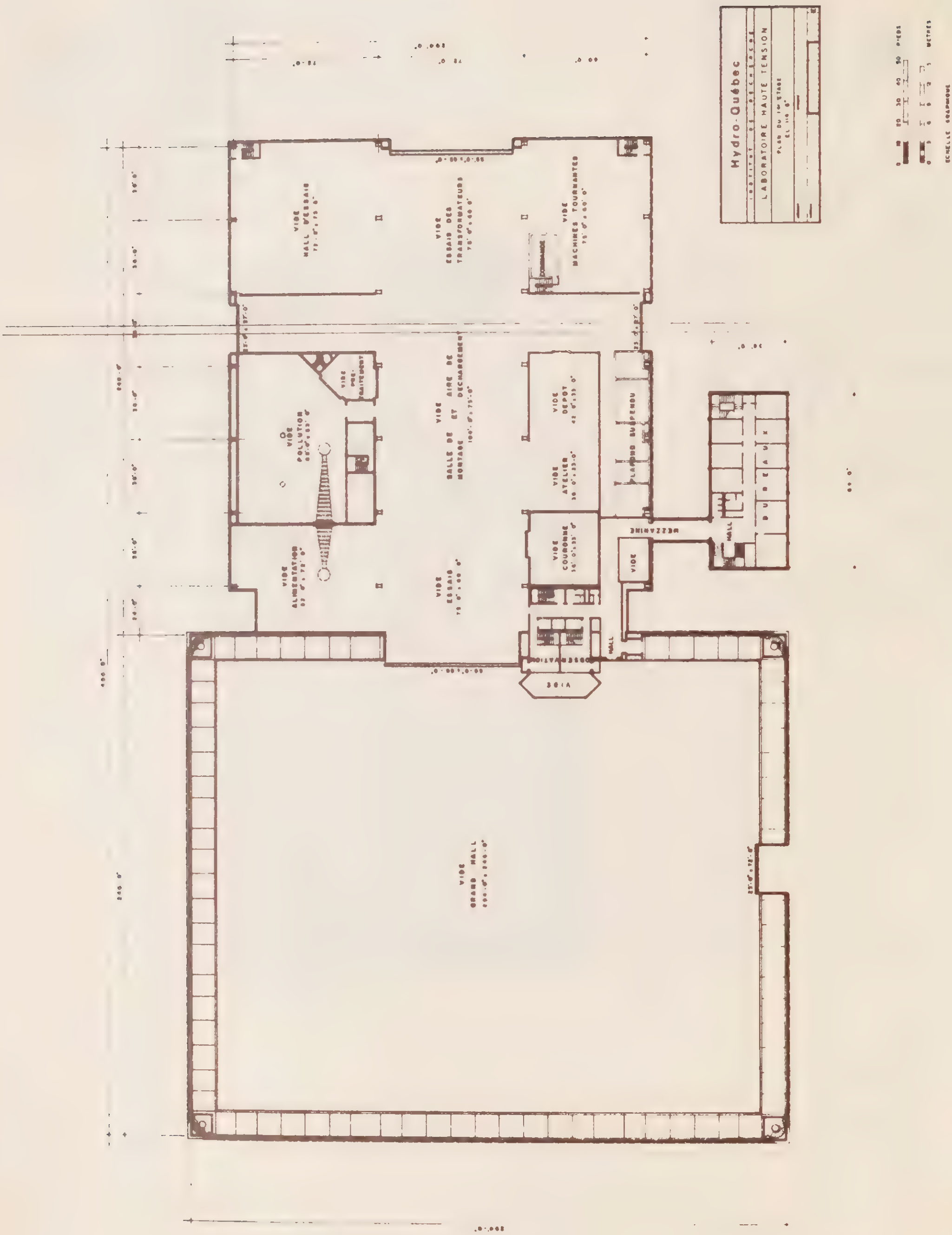
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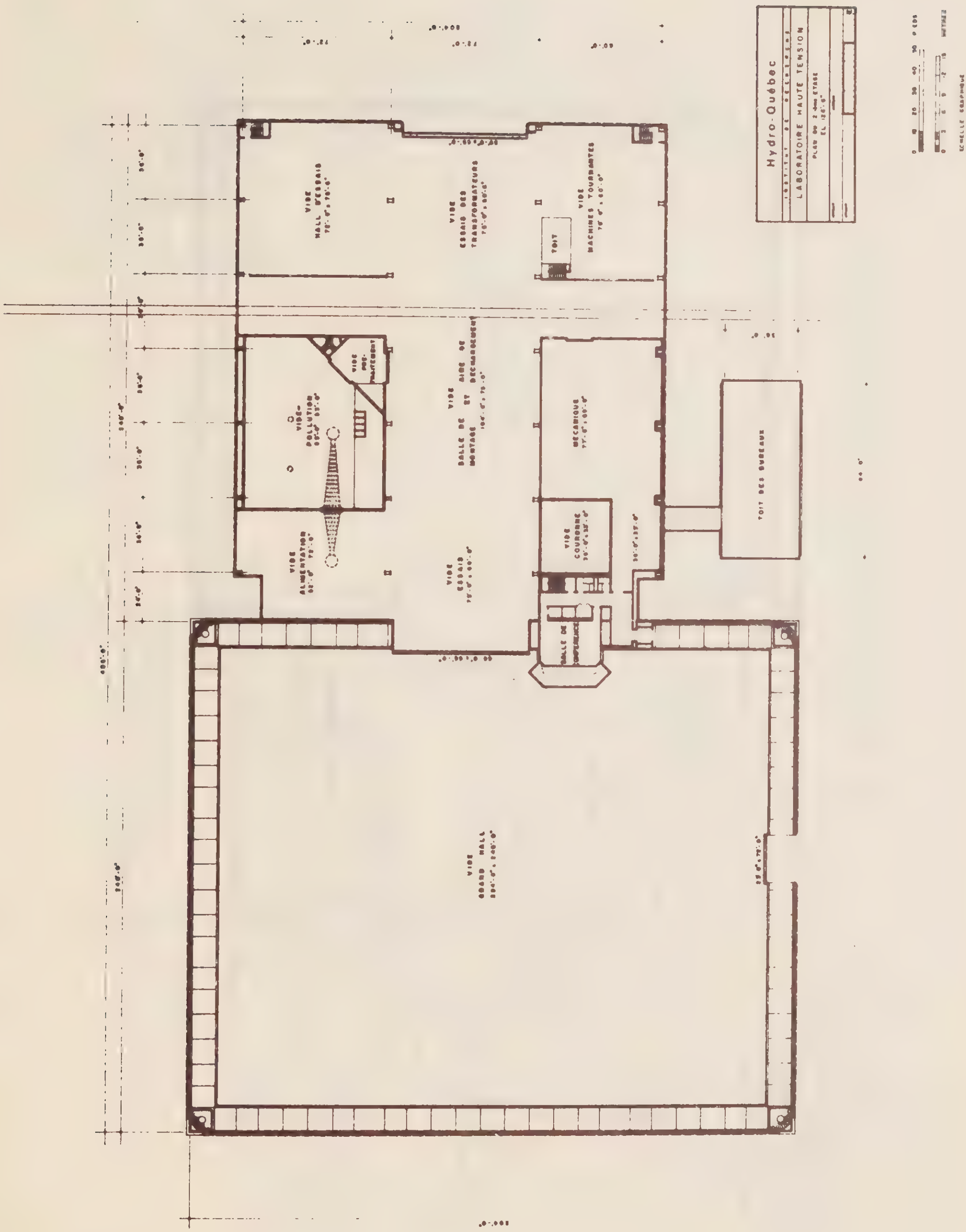
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VIDE SALLE DE MONTAGE ET AIRE DE DECHARGEMENT
MECANIQUE
TOIT DES BUREAUX
VIDE COURONNE
VIDE ESSAIS
VIDE ALIMENTATION
VIDE POLLUTION
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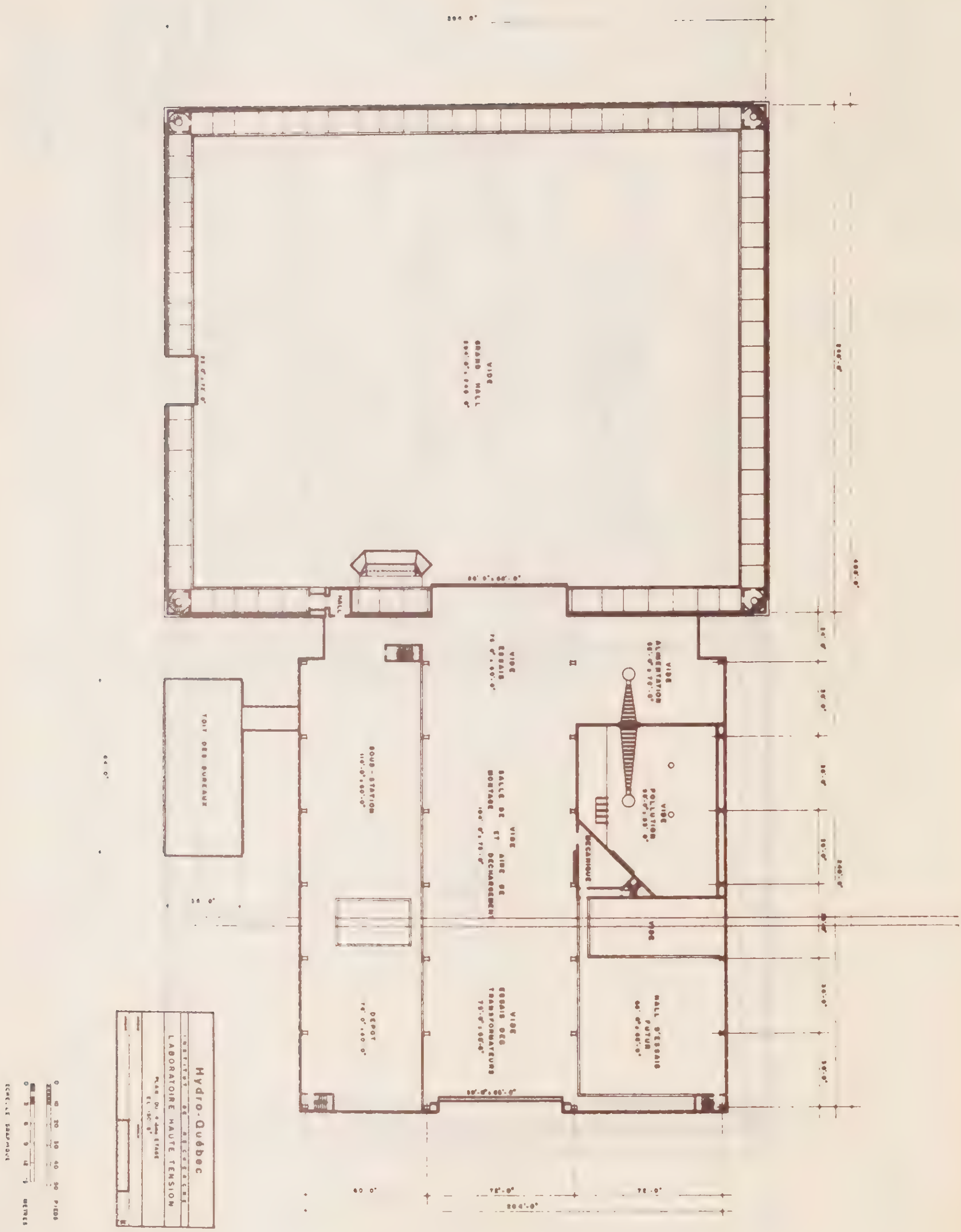
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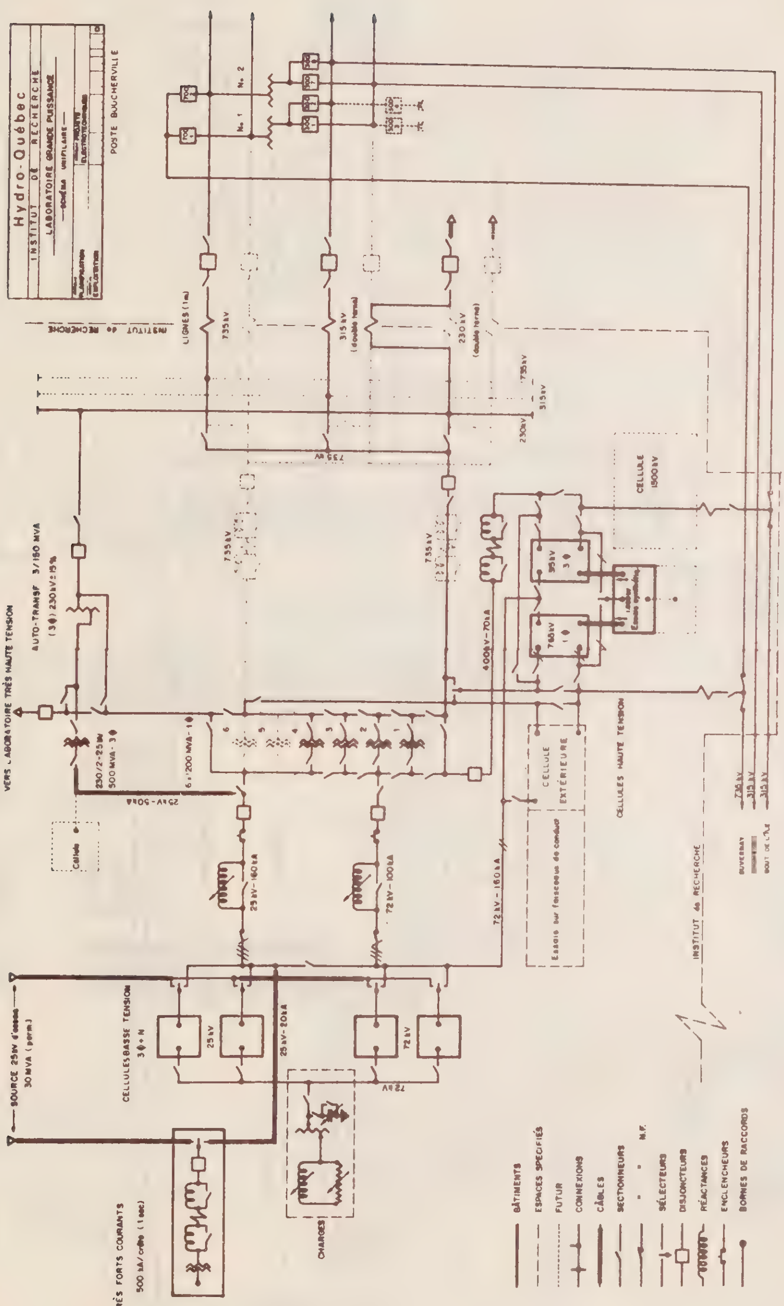
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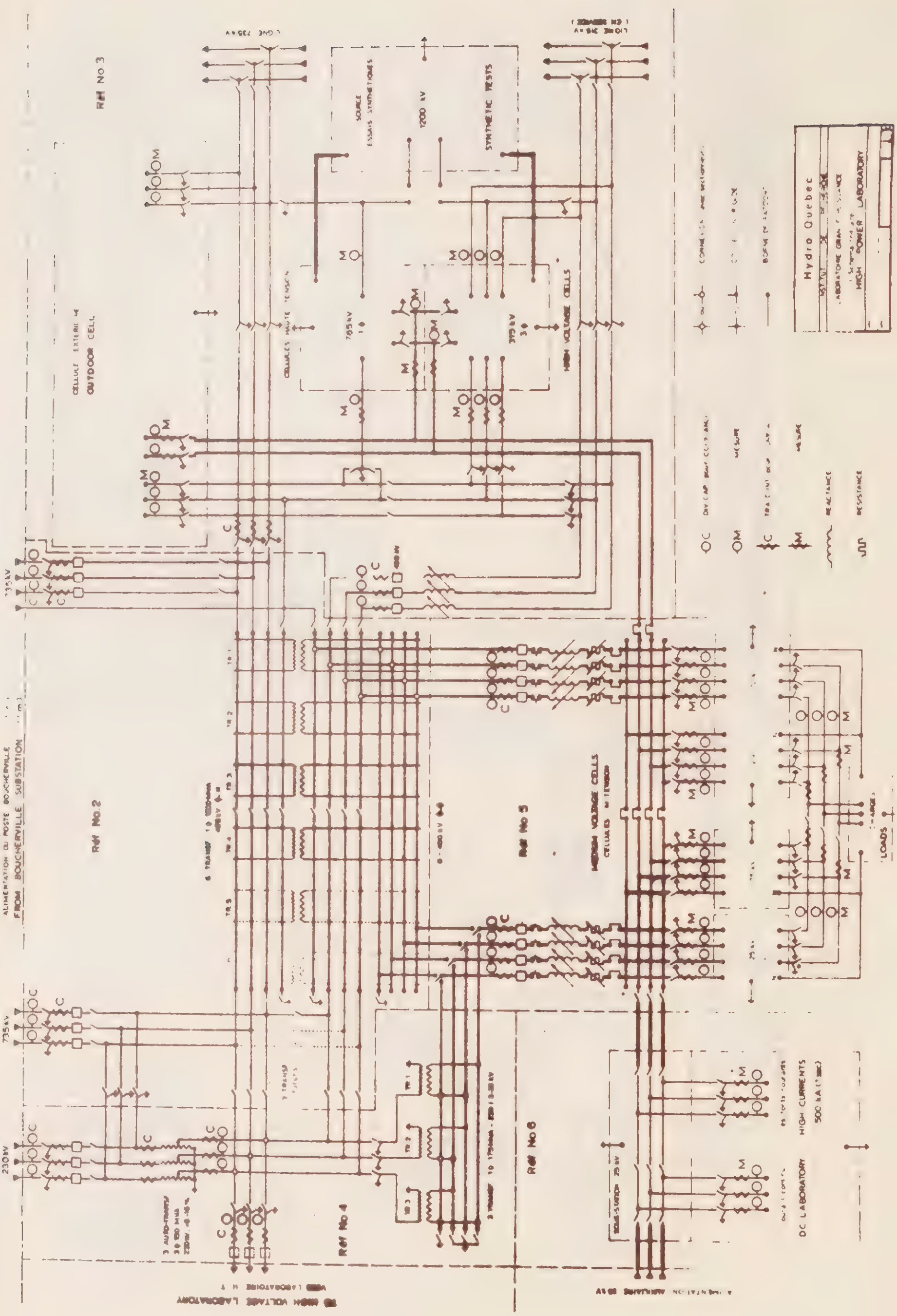
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FROM BOUCHERVILLE SUBSTATION
Ref No 2
Ref No 3
Ref No 4
Ref No 5
Ref No 6
OUTDOOR CELL
SYNTHETIC TESTS
1200 kV
HIGH VOLTAGE CELLS
MEDIUM VOLTAGE CELLS
HIGH CURRENTS
500 kA
DC LABORATORY
LOADS
735kV
230kV
HIGH VOLTAGE LABORATORY

First Session—Twenty-eighth Parliament
1968-69

THE SENATE OF CANADA

PROCEEDINGS OF THE SPECIAL COMMITTEE ON

SCIENCE POLICY

The Honourable MAURICE LAMONTAGNE, P.C., *Chairman*
The Honourable DONALD CAMERON, *Vice-Chairman*

No. 74

WEDNESDAY, JUNE 25th, 1969

WITNESSES:

Bell Canada: Mr. A. G. Lester, Executive Vice-President, Planning and Research; John Labatt Limited: Mr. J. D. Cronyn, Executive Vice-President, Dr. G. E. Hall, Research Consultant, Dr. J. A. Pearce, Research Administrator.

APPENDICES:

178—Brief submitted by Bell Canada
179—Brief submitted by John Labatt Limited

20672—1

MEMBERS OF THE SPECIAL COMMITTEE
ON
SCIENCE POLICY

The Honourable Maurice Lamontagne, *Chairman*

The Honourable Donald Cameron, *Vice-Chairman*

The Honourable Senators:

Aird	Grosart	Nichol
Belisle	Haig	O'Leary (*Carleton*)
Blois	Hays	Phillips (*Prince*)
Bourget	Kinnear	Robichaud
Cameron	Lamontagne	Sullivan
Carter	Lang	Thompson
Desruisseaux	Leonard	Yuzyk
Giguère	McGrand	

Patrick J. Savoie,
Clerk of the Committee.

ORDERS OF REFERENCE

Extract from the Minutes of the Proceedings of the Senate, Tuesday, September 17th, 1968:

"The Honourable Senator Lamontagne, P.C., moved, seconded by the Honourable Senator Benidickson, P.C.:

That a Special Committee of the Senate be appointed to consider and report on the science policy of the Federal Government with the object of appraising its priorities, its budget and its efficiency in the light of the experience of other industrialized countries and of the requirements of the new scientific age and, without restricting the generality of the foregoing, to inquire into and report upon the following:

(*a*) recent trends in research and development expenditures in Canada as compared with those in other industrialized countries;

(*b*) research and development activities carried out by the Federal Government in the fields of physical, life and human sciences;

(*c*) federal assistance to research and development activities carried out by individuals, universities, industry and other groups in the three scientific fields mentioned above; and

(*d*) the broad principles, the long-term financial requirements and the structural organization of a dynamic and efficient science policy for Canada.

That the Committee have power to engage the services of such counsel, staff and technical advisers as may be necessary for the purpuse of the inquiry;

That the Committee have power to send for persons, papers and records, to examine witnesses, to report from time to time, to print such papers and evidence from day to day as may be ordered by the Committee, to sit during sittings and adjournments of the Senate, and to adjourn from place to place;

That the papers and evidence received and taken on the subject in the preceding session be referred to the Committee; and

That the Committee be composed of the Honourable Senators Aird, Argue, Bélisle, Bourget, Cameron, Desruisseaux, Grosart, Hays, Kinnear, Lamontagne, Lang, Leonard, MacKenzie, O'Leary (*Carleton*), Phillips (*Prince*), Sullivan, Thompson and Yuzyk.

After debate, and—
The question being put on the motion, it was—
Resolved in the affirmative."

Extract from the Minutes of the Proceedings of the Senate, Thursday, September 19th, 1968:

"With leave of the Senate,

The Honourable Senator Lamontagne, P.C., moved, seconded by the Honourable Senator Benidickson, P.C.:

20672—1½

That the name of the Honourable Senator Robichaud be substituted for that of the Honourable Senator Argue on the list of Senators serving on the Special Committee on Science Policy.

The question being put on the motion, it was—
Resolved in the affirmative."

Extract from the Minutes of the Proceedings of the Senate, Wednesday, February 5th, 1969:

"With leave of the Senate,

The Honourable Senator McDonald moved, seconded by the Honourable Senator Macdonald (*Cape Breton*):

That the names of the Honourable Senators Blois, Carter, Giguère, Haig, McGrand and Nichol be added to the list of Senators serving on the Special Committee on Science Policy.

The question being put on the motion, it was—
Resolved in the affirmative."

ROBERT FORTIER,
Clerk of the Senate.

MINUTES OF PROCEEDINGS

WEDNESDAY, June 25, 1969.

Pursuant to adjournment and notice the Special Committee on Science Policy met this day at 8.00 p.m.

Present: The Honourable Senators Lamontagne (*Chairman*), Blois, Bourget, Cameron, Carter, Phillips (*Prince*) and Yuzyk—7.

In attendance: Philip J. Pocock, Director of Research (*Physical Science*).

The following witnesses were heard:

BELL CANADA

Mr. A. G. Lester, Executive Vice-President
Planning and Research

JOHN LABATT LIMITED

Mr. J. D. Cronyn, Executive Vice-President

Dr. G. E. Hall, Research Consultant

Dr. J. A. Pearce, Research Administrator

(*A curriculum vitae of each witness follows these Minutes*)

The following are printed as Appendices:
No. 178—Brief submitted by Bell Canada
No. 179—Brief submitted by John Labatt Limited

At 10.30 p.m. the Committee adjourned to the call of the Chairman.

ATTEST:

Patrick J. Savoie,
Clerk of the Committee.

CURRICULUM VITAE

Cronyn, John Bruce, B.Sc., P. Eng.: Mr. Cronyn was born in London, Ontario in 1920, and served as Lieutenant, R.C.E., in England and N.W. Europe from 1942-1946. He received the B.Sc. degree from University of Toronto in 1947, joined John Labatt Limited as an Apprentice Brewer, and has advanced through the company becoming Executive Vice-President in 1962, the position which he currently holds. Mr. Cronyn is a director of London Life Insurance Company, John Labatt Limited, Ogilvie Flour Mills Company Limited, Delmar Chemicals Limited, Parkdale Wines Limited, Schwarz Services International Limited, Kemp Products Limited and Talisman Resorts Limited. He has held executive positions in a number of organizations: Chamber of Commerce, United Community Services, Boy Scouts Association, Victorian Order of Nurses, and Corporation of Huron College.

Hall, George Edward, A.F.C., E.D., M.S.A., M.D., Ph.D., LL.D., D. ès S., D.Sc., F.R.S.C.: Dr. Hall was born in Lindsay, Ontario on October 10, 1907, son of George William and Etta (Brandon) Hall, both of Lindsay, Ontario. He was formerly President and Vice-Chancellor, The University of Western Ontario, London, Ontario, 1947-1967. He attended Lindsay Collegiate Institute; Ontario Agricultural College, University of Toronto, and studied abroad in England and Belgium. Dr. Hall did graduate studies under Sir Frederick Banting at Banting Institute, Toronto (1929); obtained Master's Degree in Biochemistry (1931); graduated in Medicine in 1935; Ph.D. in Physiology (1936) and the Reeves Prize for Medical Research. He served on the staff of the Department of Medical Research, Banting Institute, University of Toronto from 1935 to 1939 and attained the rank of professor. He has publications of scientific nature in Biochemistry and Physiology. Before the outbreak of World War II he joined the armed services, was in charge of Aviation Medicine for the Royal Canadian Air Force and served from 1939 to 1945, during which time he was a member of several research committees of the National Research Council, and was awarded the Air Force Cross (1942), the Efficiency Decoration (1943) and the American Legion of Merit (1945). He holds the following honourary degrees: D. ès S. (Laval 1951); LL.D. (Windsor 1954, Madras 1957, Queen's 1958, Toronto 1959, London 1963); D.Sc. (Guelph 1967). He is a Knight Commander of the Order of St. Gregory the Great (Vatican) 1967. In 1945 Dr. Hall became the Dean of Medicine at the University of Western Ontario, and in 1947 became the President and Vice-Chancellor. Retired in 1967. He has been a member of the following organizations: Research Council of Ontario, National Research Council, National Cancer Institute (President 1950-51), Advisory Medical Board, Ontario Cancer Treatment and Research Foundation, Canadian Forces Medical Council (Chairman 1962-66), The Canada Council, Ontario Council of Health, National Productivity Council, Association of Universities and Colleges of Canada (President 1956-57), Association of Commonwealth Universities. (Chairman 1963-65), and several government commissions. Currently Dr. Hall is a Director and Chairman of the Board of Northern Life Assurance Co. and a Director of International Business Machines Co. Ltd. (Canada).

Lester, Alexander George: Alexander G. Lester is executive vice-president, planning and research, of Bell Canada. Closely associated with Northern Electric Company Limited, the wholly-owned manufacturing and research subsidiary of Bell Canada, he is a member of Northern Electric's board of directors and of the research and development administration committee. Born and educated in Montreal, Mr. Lester joined Bell in 1922, and from that time to 1942 occupied a variety of posts in the engineering department. Wartime service was in the Royal Canadian Signals. In 1949-50 he was loaned to the Federal Government to attend the National Defence College and, in 1952, served as associate director of the electronics division of the Department of Defence Production. In 1953 Bell formed a special contract department to be responsible for major defence communication projects. Mr. Lester became assistant general manager and, in 1955, general manager of the department. In 1958 he was made vice-president, engineering, of the company and, in 1965, was appointed to his present position. Mr. Lester is a member of the Corporation of Professional Engineers of Quebec and the Engineering Institute of Canada, and a director of the New Brunswick Telephone Company Limited and the Maritime Telegraph and Telephone Company.

Pearce, Jesse Arthur, B.A., M.A., Ph.D., P. Eng.: Dr. Pearce was born in Regina, Saskatchewan in 1914. He received the B.A. in 1938 and M.A. in 1939 from Queen's University and the Ph.D. in 1941 in Physical Chemistry from McGill University. During the next year, he held a National Research Council Fellowship in NRC's Division of Applied Biology. He then joined their staff working on wartime food chemistry problems. In 1949, he joined the Atomic Energy Project, as Head of the Radiation Hazards Control Branch, and in 1951 became Director of Research Personnel for Defence Research Board. Being interested in the application of science in Canadian Industry, Dr. Pearce joined Chr. Hansen's of Canada, Ltd. in 1953, preparatory to establishing his own consulting business in 1956. In 1959, he joined John Labatt Limited, where he is presently Administrator of Scientific Services. He has published over 100 scientific and technical papers.

THE SENATE

SPECIAL COMMITTEE ON SCIENCE POLICY

EVIDENCE

Ottawa, Wednesday, June 25, 1969

The Special Committee on Science Policy met this day at 8:00 p.m.

Senator Maurice Lamontagne (Chairman) in the Chair.

The Chairman: Honourable senators, we have this evening two quite different companies. We are beginning to get used to diversity of representation but unanimity in views. I have looked at the briefs and although they are quite different there is at least a common approach to the problems that we are investigating. As usual we will have an opening statement, first of all from Bell Canada. I presume that Mr. Lester will speak on behalf of the company, although he has no telephone tonight.

Mr. A. G. Lester, Executive Vice-President, Planning and Research, Bell Canada: Sometimes the telephone is a relief to get away from, Mr. Chairman, even for telephone people.

Honourable senators, to orient ourselves, my name is Lester, as the senator has mentioned. My job is executive vice-president of Bell Canada. Perhaps the significant thing really as far as this committee is concerned is that for the last eleven years I have been the senior technical officer in Bell. I have been in charge of what you might say is the innovative process, which is technological innovation. With some assistance of Northern Electric I have been attempting to guide the research and the development program of the two companies. I have Mr. Inns with me. Mr. Inns has recently been appointed vice-president, engineering. Amongst other activities he is going to be actively engaged in the coordination and guidance of the R and D program. We are somewhat in an interregnum of handing over the reins from one to the other.

I do not propose to read the Bell Canada brief. I presume that you gentlemen have had an opportunity of reading it. I did think I would cover a couple of the high spots and a few things which may not be emphasized in the brief.

First, we feel strongly that in setting science policy the overall purpose of research and development should be kept clearly in mind. In my book that means that the economical, sociological and ecological well-being and enrichment of Canadians is the chief and final purpose of scientific policy. In line with this we consider that more R and D work needs to be done in the social sciences.

We have nibbled at this I would say in Bell, and only a nibble. We have got two projects underway: one on urban development, a study in association with the University of Toronto. We are also carrying on in Ottawa a two year experiment with the school boards of Ottawa and with the government of Ontario. This relates to information retrieval using coaxial cables to schools and TV screens in the classrooms. The teachers have control of what they take from a library of 1,700 films. These are both experiments and we think that this may be useful.

We are also participating in some United States studies on job enrichment and motivation. We are currently creating one or two positions in the company and searching for one or two people at the doctorate level in sociology. I feel myself that more of this kind of work should be done, not only in our own company, but in industry generally. I also feel, perhaps this is the selfish part of it, that some of the incentive programs of the government should be broadened to permit encouragement, if you will, also some incentive in the sociological programs because by and large they do not qualify under some of the rules that have been laid down.

The third point is that we would agree with the science council that the predominant part of Canada's R and D program should be mission-oriented. As Dr. Solandt has said, that does not mean that basic research should be

neglected. In this country we have a somewhat disproportionate amount of a rather small R and D program devoted to basic research. Most of this development work in our opinion should be done in industry, with the government or the universities concerned primarily in the basic research. In other words, the universities and the government would be primarily interested in the R part of R and D and industry, by and large, in the D part of it. In my view we should be working towards a total of about 70 per cent of the total of the R and D expenditure in the country to be done by industry. There is nothing magic about 70 per cent except that is about the level that has been attained in the United States. We are almost the reverse of that. We are somewhere around 25 per cent to 30 per cent being done by industry. This says, amongst other things, that Canadian industry is not nearly enough innovative-minded, that there should be encouragement. The government incentive programs need a new look. The IRDIA program in particular encourages growth in R and D all right, but it is not much of an incentive to a company which has attained a fairly high level of R and D and is continuing at that level. It is based on the difference between this year's expenditure and the average of the last five years. So that you get an incentive on the increase but not on the total.

We made a number of other specific recommendations in the government field. More government and industry joint task forces to study specific technological problems. The government should call industry in at an early stage of its planning to ensure efficient effort. I speak with some feeling on this. I have been in on some government projects too late in the game and I have felt that we had some waste of manpower because of doing it. I think if the government pools the industry representatives who have been identified early in the planning process, then the manpower is most effectively used. That the government departments, those technically based, should have well informed technical people in the areas in which they are dealing with industry. The Science Council should continue its role as a high level body. Likewise, the Department of Industry, Trade and Commerce should continue and intensify if possible its highly useful cooperative efforts with industry's developing technology. We recommend a greater degree of industry participation and mission-orientation in the National Research Council programs. Our associates in Northern had some words to say about this in their brief with regard to the suitability of some of the NRC patents and the sort of reluctance of industry to pick them up. More industrial participation might be useful. Greater government participation, both federal and provincial, in the study and development of technological aids to education is required. Here I am thinking of this information retrieval system that I mentioned earlier and such things as programmed instruction, which has been going ahead in great style in the States and in which we are lagging behind in Canada.

While not directly a matter of science policy, we feel that Canada's technological advance would benefit from some revision of the combines legislation. In major industries it is important today to be able to compete with the giants in the international markets. This dictates in general large and powerful companies which may well suggest mergers in Canada, could suggest mergers in Canada's interest. Such action is recognized as desirable in the international market. The tendency under our legislation seems to be for the government to frown on similar action in the domestic market. From the practical standpoint the efficiency in the economy of scale and financial power of the company has to be based on a strong domestic base if it is going to really be strong internationally. You really cannot separate the two.

Then coming to my own industry, we are in the middle of a tremendous revolution in electronic components. We strongly recommend that the government, as they have shown evidence of doing, should give support to Canadian efforts in the field of microminiaturization. That is the development of micro circuits and this kind of thing. If Canada does not establish itself in this field, then we are going to be importing these things for many years to come.

Finally a word about the size of the Bell-Northern program, which I thought the committee might be interested in. The R and D program in total ten years ago was in the order of $10 million. The brief says that for 1969 it is $50 million. Our view on that was some months ago. It is about $53 million for 1969, of which roughly $9 million is imported technology. That is patents, patent licensing arrangements and technical information from our associates in the Bell system in the United States. The other $44 million, about $2½ to $3 million of this is carried out within Bell by the scientific people who have been

reporting to me and will now report to Mr. Inns. Of the remaining $40 odd million, the majority is done in the Northern Electric laboratories. This amount is essentially developing hardware. Some of it is basic research. Of the $53 million, $6 million to $8 million is basic research, but the vast majority is development of things, of systems and of services. We have the largest industrial laboratory effort in Canada. About half of all the electronic R and D work industrially consists of a central laboratory and six branches. By the end of this year there will be about 2,100 employees in the lab proper and in the branches, of which one-third will be technical people, that is graduate engineers and so on. About two hundred will be people with doctorate and masters degrees and senior degrees of various sorts. How does it grow and why does it have to be that big? The communication industry is a voracious user of innovative enterprise. It grows at a tremendous pace. We live across the border from a very innovative people. The businessman in Montreal wants to have the same kinds of communications as his confrères in New York. Consequently we have in Canada the desire and the necessity for that matter of having the same breadth of offerings in the way of communications as is the case in the United States. The Bell laboratories alone in the United States will spend this year in the order of $300 million on research and development. Our $53 million does not look big, although it is big in actual amount it does not look big in that relationship. My feeling is that this will grow, provided we have the financial ability to make it grow, at something in the order of $5 million a year for the next four or five years and maybe beyond that. This will be to try and keep up to the pace, because we are really trying to develop in Canada a Canadian enterprise, we have to fill the communication needs of the country and to fill the export needs.

I think that is about it, senator, in very brief summary.

The Chairman: Thank you very much, Mr. Lester. I noted that you have not raised a problem that was covered in your memorandum, that you wanted to have more lines of communication with the government. We will probably come back to this later on.

Mr. Lester: I tried to telescope some of the things that were said in there, sir, yes.

The Chairman: Next we have the Science Council which is advising John Labatt Limited. I say this because I have on my list here three consultants. This is unusual I am sure. I will introduce at this stage Mr. Cronyn, who is one of the consultants. He will certainly explain this curious situation, because this is establishing a precedent before this committee, to have three consultants on behalf of a company.

Mr. J. D. Cronyn, Executive Vice-President, John Labatt Limited: Mr. Chairman, honourable senators, ladies and gentlemen, I will start off by introducing my associates and clarifying these misnomers. Dr. Hall, who I am sure you all know or know of, is a consultant to John Labatt Limited in the research area and has been for a number of years. Dr. Pearce is not a consultant. He is a full time employee of John Labatt Limited in charge of administering our research efforts. I myself are not a consultant. I am an executive vice-president of the company. I am not sure how this consultant got in here. We do practice consultative management in our operations, but we are not consultants.

I will very briefly summarize our presentation just to refresh your memories. It is our view that science is not a goal in itself but a tool to be used in pursuit of these goals. Therefore the objective of a national science policy is to support the attainment of national economic goals. As a result it is our feeling that a truly objective national science policy can only be established when our national economic goals have been delineated. There are many ways to set our national goals. For example, the Economic Council of Canada has indicated such things as full employment, resasonable stability of prices and an equitable distribution of rising incomes. The Engineering Institute of Canada's recommendations to you have stressed improvement in transportation in Canada as a national goal. We have emphasized the maximization of the potential advantages of Canada's northern arctic regions as a goal. Regardless of the manner in which the national goal or goals are expressed we feel that it is important that they be expressed and form the basis for the establishing of the objectives of a national science policy. The science policy should then encompass two areas. The first area is continuing short term innovative work to apply the results of research and development originating in Canada and elsewhere to assure a high rate of economic growth in the short

term. Second, long term research and development toward the greater utilization of Canada's mass of land, water and natural resources. The objectives of a science policy must be such that they can be translated into an integrated working plan involving the universities, the community colleges, government, laboratories and industry. The money to be allocated for scientific work can then be determined from the working plan to make the plan succeed. Government laboratories or branches doing research and development in a common field should be combined into a single scientific unit to maximize productivity and minimize cost while at the same time making it easier for industry to have access to the information produced. Some unification of university scientific work as well as some organized decentralization may also be necessary. The diversity of bodies taking regulatory action in a common field can delay and inhibit the development and innovative phases of programs. This leads us to recommend that federal government branches or units regulating a common field be combined into a single regulatory unit. Failure of regulations to keep up with improvements in modern processing can also retard innovation. We recommend that federal government regulatory bodies do a state of the art review at regular intervals to bring their regulations into line with advances and even more important with impending advances in the art.

We also recommend flexible pricing practices that permit Canadian manufacturers to use Canadian produce for secondary processing in Canada. This would also allow them to end up being competitive in world markets. In the matter of government support for industrial research we feel that the National Research Council is to be complimented and commended on its industrial research assistance program. We believe that it might be improved by extending the granting period from five to ten years and dropping the requirements for additional personnel for new projects. By the way, these points which deal directly with the various incentive programs have been presented by us to the Minister of Trade and Commerce and to the president of the Treasury Board. They are attached as an appendix to our submission.

The PAIT program should express more clearly the freedom allowed to produce outside Canada in areas that cannot be served competitively from Canada. This program should also give greater recognition to the higher cost of development and the innovative stages of scientific work. We recommend that assistance be available for amounts approaching one hundred per cent of the cost of materials and special equipment needed for the project. We also recommend that a basic grant be given to the Canadian-controlled and based companies and foreign companies that operate on a world wide basis from Canada for all research and development in any one year, regardless of the expenditures made by that company in prior periods.

Grants in aid of industrial scientific research and development must be consolidated into one program. We would recommend a pattern of support along the lines of IRDIA, but suggest that liaison officers be available from the appropriate government research establishment to the grantee at the latter's request.

One final item which we would like to put forward for the record, even though not directly included in our brief, has to do with the social sciences. I think it has been of general concern that socially we have not kept up to the tremendous developments in the natural science fields and many human problems which are arising and will continue to arise from these developments. As a result of the Round Table on the Social Aspects of Science Policy in March and more particularly from the very thoughtful and worthwhile address given by your chairman, Senator Lamontagne, at that conference, it would appear that two actions should be given immediate consideration.

First, that research work in the social sciences carried out by industry qualify for research incentives in the same manner as does research in the natural sciences. I am glad to hear that Bell Canada have suggested this in their brief.

The Chairman: As a matter of fact, this is the first time that this has been suggested and I am glad to see this unanimity tonight.

Senator Phillips (Prince): Amongst the witnesses, Mr. Chairman.

The Chairman: Oh, yes.

Mr. Cronyn: Yes, I am sure it came from other sources. Secondly, that social scientists be included on the science council. They can then contribute towards the formation of a

national science policy and are in a position at all times to point out the social implications that will arise therefrom.

Thank you, sir.

The Chairman: Thank you very much. On this note of unanimity we will begin to inquire about the areas of disagreement.

Senator Yuzyk: I am going to ask first of all a technical question with regard to the brewing industry. I notice mention was made about continuous process brewing. Is that a Labatt's innovation or is this also done in consultation with other brewing organizations?

Senator Phillips (Prince): Mr. Chairman, may I interrupt and say I think that is an odd question for a temperance adherent.

Senator Yuzyk: Moderation.

Mr. Cronyn: This is an interesting development which Labatt worked on quite a few years ago. They came up with some of the original world patents on the continuous production of beer. We ran into conflict with the same type of invention being developed in New Zealand at the same time but with completely no connection at all. To settle the patent conflicts, particularly in the United States and some other major countries in the world, we joined forces with the New Fealand companies and put together a joint international company which holds the patents for continuous production of beer. In New Zealand the bulk of the beer is now produced in this manner. In Canada we are still on the batch process, because we are not entirely satisfied that we can produce the type of beers that are popular in North America by this process. It is going to come, as sure as we are sitting here tonight. It is a matter of time and more knowledge.

Senator Yuzyk: Now to come to Bell regarding satellite communications. Has there been any consultation by government agencies with Bell Company in the launching of satellites and in the production of satellites?

Mr. Lester: Oh, yes, senator. There has been a long history of discussions, as you probably know from the press and the hearings. Actually the consultation started back in 1962 with the then Deputy Minister of the Department of Transport. Growing from that the government undertook the Mill Village project, which was an international one and the COTC people operate it. Then Bell took on the project of developing a terminal or a test ground station suitable for arctic operation. This is in working condition at Bouchette, which is seventy miles north of here. When the project livened up, as it were, on a domestic system our thought, of course, was to get Northern Canada into the northern telephone network which was where the main effort was. Since the original proposal of the common carrier, which was back in the spring of 1967, there have been extensive consultations. As you know, following the white paper the government decided this was something that should be done under government auspices and finally on a sort of joint arrangement. The actual engineering of the system, which has not been done yet, let us be clear on that, the corporation is not formed yet, but the preliminary engineering has been done by the Department of Communications. There are some telephone people, I think a total of four in there now on loan, in effect as employees of the Department but they are seconded from Bell and the other telephone companies.

Senator Yuzyk: Has Bell received funds in the R and D aspect of it?

Mr. Lester: Mr. Inns points out we have made claims and presumably will be allowed IRDIA claims on this Bouchette expenditure in the normal fashion. There has been no subsidy other than that of course.

Senator Yuzyk: This question will be of both companies with regard to your relations with the government agencies dealing with research or innovations or industry in general: have you found that these relations have been satisfactory, or would you recommend a better mechanism for relations with the government?

Mr. Lester: Speaking for Bell and I know Mr. Cronyn might have some views on his own industry, I would think that the relationship, the consultation could be closer. I do not think we really are close enough to National Research Council, for example. I would like to see some stronger lines in there. We are hopeful that we will perhaps be more closely tied in because of the association now in the new Department of Communications of some of the scientists from DRTE. Our contact in the technical departments of the government seems to be more with the Department of Industry, Trade and Commerce than it is

really with the research departments. While they in effect are encouraging R and D they are not R and D people themselves.

The Chairman: As I was saying a moment ago, we are trying to develop more lines of communication.

Mr. Lester: I think it is important, sir, yes.

Senator Yuzyk: I think you do make the suggestion for a new department of science and technology?

Mr. Lester: No, sir; I do not think we do. We suggested that we felt that it was important to have able technical people in each of the technically based departments for consultation. There is nothing more frustrating to a person from industry than talking to somebody who is not familiar with the subject. We would not think that a separate scientific department is the right thing to do. Whether there is room for cabinet representation of a minister and so on is something which should be left with the government. It might be a logical thing.

The Chairman: Why should it be left to the government? You have no views on this?

Mr. Lester: Yes; my personal view, senator, would be that if we could find the right man, a minister of science in the cabinet would be a very useful individual. I have a lot of questions myself and it is so stated in the brief about creating another department. I have a fear that there are too many people with scientific responsibilities or pseudo-scientific responsibilities in the government now. I do not think they get tied together.

Senator Bourget: Do you think that the Minister should be a scientist himself, or an engineer, or anything like that?

Mr. Lester: I would like to see a combination of a scientist and a manager, sir. A pure scientist, and some of my friends may disagree, might have some difficulty in the political arena.

Mr. Cronyn: Speaking for Labatts, our lines of communication have been pretty good. I think the one point we bring up is that there are perhaps too many departments involved in the same area. It is this duplication that gets us into trouble.

Dr. G. E. Hall, Research Consultant, John Labatt Limited: Mr. Chairman, Labatts is in the food industry, if you call beverages a food industry. There are fields of protein research in which Labatts are very much interested. As an example, if you take proteins, casein in cheese, you try to deal with government departments. You find that there are at least three, if not four, government departments which have scientific elements within them. Within those elements there are people dealing with proteins. One is dealing with fish, which is a protein. Another is dealing with frozen fish, frozen meat, meat proteins, casein per se. Then the Food and Drug Act people are concerned with additives which are permissible in cheeses. A person from industry may go to one department and they think well, this is the element where we should be and discuss our problems with these people. You find that there is another department which we should have seen as well. It is not always necessarily the fact that people in one department know what people in another department are doing. Without being critical we feel that there is room for this committee, your committee, Mr. Chairman, to have a good look at the duplication in scientific efforts within the multitudinous branches of government.

When one suggests that, I think one has to be realistic and recognize the fact that history plays a great part in this type of development. The need arose long before there were things like the National Research Council, the Canada Council, et cetera. A relevant department sets up a research entity as well as its legislative and regulatory functions. Then another department finds that there is an element of research required which has not been covered. In order to satisfy the realistic demands and needs it too creates a department in a different field, of course. 1970 is different from 1912 and 1925. Rather than being critical about it at all, we simply suggest that here is an area that should in this day and age, when so much attention is being paid to R and D, have a good look taken at it and say is this the right way to organize our in-government research activities? Again, how much easier can it be made for industry to cooperate with government in these various essential fields? There are roadblocks, very definitely, in research, the whole attitude. Then one, if I may go back to the university situation, I think one must recognize...

The Chairman: I think I must mention at this stage, doctor, that Dr. Hall was also the

President of the University of Western Ontario when he was a member of the Canada Council.

Dr. Hall: The National Research Council.

Senator Cameron: Can we hold him responsible for some of this duplication?

Dr. Hall: Perhaps so. This whole field, Mr. Chairman, is one in which I am naturally vitally interested. I tried to bring this point of view as a consultant to Labatts to the fore, and it is perhaps with experience that one can make certain suggestions. Certainly I am not in a position and I do not think anyone else is to say this is how it should be done, but I think we should have a look at it. So many people, for instance, say well, we are spending too much money on basic or fundamental research in the universities. You can define basic or fundamental any way you wish to, as opposed to applied research and development, et cetera. These are all definitive types of things, but they overlap a great deal. Actually the support of fundamental and basic research in the universities is the least expensive form of support for research. Without this type of research in the universities, which is from my point of view an essential function of a university, it is more like supporting music. You are supporting creative talents; the end result may be impossible to define and I think this is a good thing in universities. But to try to compare expenditures in the fundamental and basic sciences in universities with the vast sums which are being, and should be, expended in so called R and D in industry and government, I think is erroneous. They are two completely separate and distinct things. The support of research and the conduct of research in the universities is almost like supporting culture. It is an inherent thing in humanity and without this, Mr. Chairman, where would industry and government be if the cupboards of knowledge were not kept very full by the university scientists? They have done this work without, in most instances, any goal attached, other than pure performance and discovery of new knowledge.

Senator Yuzyk: What proportion, Dr. Hall, of funding in research and development, including innovation, would you assign to basic research?

Dr. Hall: Mr. Senator, I cannot answer that question.

Senator Yuzyk: More or less; one-quarter of all the spending, or 10 per cent?

Dr. Hall: I am sorry, I do not know and I do not know any person else who does know.

Senator Yuzyk: We have had suggestions.

Dr. Hall: Yes; I could make suggestions too, but I do not think that I have any basis for those suggestions. They are two different things. That is one element of research in universities. The other one is the development of manpower. Without the universities doing this basic type of research and in the process producing people in science, where would government research and development and industrial research and development be? There would not be any. The development of good graduate schools, not only in the natural sciences and engineering, but in the social sciences is required. I am completely in agreement with the statements of Mr. Cronyn and Mr. Lester that this is a fundamental phase that we have neglected too long.

Senator Phillips (Prince): I will leave Labatts alone. On several previous occasions we have had witnesses refer to the amount of money Bell Telephone is spending on R and D in Canada and, if I may, may I begin with a semi-facetious question. I refer to their brief, in which they state that they are spending \$50 million in 1969. I presume this is not a new figure. I assume that your figure on research has been somewhat in the figure of \$50 million for the last few years. As one who likes to use the telephone and who gets rather exasperated with it at times, I would like to know.

The Chairman: You have to specify the location though, Ottawa or PEI?

Senator Phillips (Prince): It is the same; there is no difference. Can you explain to me how you can spend that much money in research and I cannot make a direct long distance dialing without meeting this recording, or being interrupted and saying, will you please check the number you have dialed, and have you dialed recently, and so on, and I am dialing my own home phone number? Can you tell me how you can spend that much money on research and come up with a recording?

The Chairman: This is a question of privilege.

Mr. Lester: Again to be facetious our research does not extend into your brain processes as to whether you are dialing the right number or not.

Mr. Phillips (Prince): This is when I am half-way through the phone call.

Mr. Lester: Again I don't understand this. If you are half-way through the phone conversation and are talking to your end party this is certainly something wrong with the equipment that is doing this.

Senator Phillips (Prince): Can you give us a breakdown? You say you are spending $50 million and you are giving no breakdown. I am not asking you to reveal company secrets, but can you give us a breakdown on the $50 million? As I say, I want to respect the fact that you may want to keep certain things secret.

Mr. Lester: This would be very approximate. I mentioned the figure of $53 million rather than $50 million because we have identified some other things that were being done this year, but let us talk about the $53 million. First of all, we have for the year 1969, as I mentioned earlier, the purchase or importation of technical knowhow to the extent of $9 million. This is patents and technical information obtained under our services agreement with the American Telephone and Telegraph Company and Northern Electric's patent licence arrangement with Western Electric. This is a direct importation of patent rights and technical knowhow in that field. It covers the whole gamut of communication equipment from telephone cables to satellites really. It does not include satellites, but everything else, microwave systems and so on. If you lift this out of the $53 million you have got $44 million left. Approximately $8 million of that $44 million would be in basic research of the type that Dr. Hall was speaking about.

As you say, Dr. Hall, everybody has got their own definition of basic research. In our parlance it is investigation into matter and into the properties of materials that are going to be used in the communication field somewhere, without any definition of what they are being used for. For example, a lot of work has been done on ferrites, which are essential in the electronic field. A lot of work has been done in electronic components. Northern have established quite a big facility in advanced devices. This is mostly in basic electrical theory and properties of matter and amounts to about $8 million. The $36 million would divide very roughly between transmission equipment—now, this is the matter of microwave systems, satellite systems, and that type of thing, to transmit your voice from place to place, switching equipment, which is the interconnection of calls, and customer equipment, which is all the telephone sets and so on. The customer equipment would be the smaller part of it. I am really giving you a very approximate estimate here that the customer equipment would be about $5 million of that total. The transmission equipment would be approximately $15 million. This would leave you with about $19 million for switching. You can switch $1 million from one category to the other, but the biggest item by far, by a substantial amount anyway in our program, is for switching equipment.

The Chairman: Would you have some kind of rough estimate of what you do in the field of the social sciences?

Mr. Lester: The social science figure is not included here, senator. I mentioned two studies; this is quite small. Actually Northern are doing some work.

The Chairman: But all your population movement studies and all this?

Mr. Lester: The studies that I am referring to are tied in with the University of Toronto I would suppose running about $50,000.00 in the year 1969. The information retrieval project in Ottawa will cost us approximately $200,000.00 over a two year period. We would be spending, I would suppose, in the year 1969 in the order of a quarter of a million dollars on the social science groups. This would be very, very approximate, sir.

Senator Cameron: Mr. Chairman, how do they do this? Do they make a grant through the Ottawa school board, for example, or to a group in Toronto?

Mr. Lester: No, this is a participating thing, senator. What really happens is that each person pays their own shot of what they are doing. Bell provides the cable, the space in the office and the TV screens and projecting equipment, which is the major part of it. This was a substantial capital expenditure; we got the maintenance of it from the operational level. The school board provides the film; we are involved with the provincial authority as well as the Ottawa school board. They have got 1,700 films for educational purposes.

They provide two librarians to take care of the teachers' requests and get it on. These requests are coming in at somewhere between 75 and 100 a day. We have got 12 channels going out. Each party pays their own part of the expense. We are not charging the school board anything for the rental of the facilities or anything of that sort, because this is on an experimental basis. Obviously, if it becomes a commercial entity then we will have to apply a tariff on it at so much per mile or so much per installation.

Senator Phillips (Prince): I was intrigued by the fact that you state that you are a company that is 95 per cent owned by Canadians and you refer to your joint studies with what I would call the American parent company. In what way do you relate those studies to Canada?

Mr. Lester: First of all, the American parent company would not be what I would suggest it was, senator. The AT and T Company has got something in the order of between two and two and one-half per cent of the stock of Bell Canada only and this is a small parentage. We have had in addition a service contract for many years and, of course, we draw on the knowledge of their much larger R and D background and so on, for which we pay 1 per cent of our revenues per year. This is the tie-in that we have for the scientific studies of all sorts. The studies that we are talking about in job enrichment is something which has been started by the Bell system companies and Bell laboratories and participated in by our own personnel people. This is to try and sort out job motivation in large organizations, not only in telephone companies, but anywhere else. It is concentrated on what is called enrichment of the job itself, the identification that money is not the sole incentive to a good job by any means, neither are fringe benefits and so on. There is something in the content of the job and the challenge of the job, which is the right thing to do. Sociologists have been studying this for some time. This is the concentrated area and our assumption is that the human mores is much the same in Canada as it is in the United States. We are participating in this with studies in Canada as they are doing in the States, to get a cross breeding of the results. This is about what it amounts to.

Senator Phillips (Prince): You referred to micro-circuitry; I presume that you import a great deal of this material. Can you give us any idea of what the amount of the imports would be per year?

Mr. Lester: We do not import any micro-circuitry, sir.

Senator Phillips (Prince): You do not?

Mr. Lester: No, sir; Northern manufacture it all themselves. There may be the odd thing which is not done and which we might buy direct. We mentioned the 95 per cent ownership. Actually in terms of use of material the Bell-Northern performance is something in the order of 95 per cent Canadian sourced. This, when we are talking about purchases in the order of $400 million a year, is a pretty important thing. There is something like 5,000 sub-contractors of Northern which are doing some of these things.

Senator Phillips (Prince): Then why the emphasis on micro-circuitry, if you import very little?

Mr. Lester: We import very little now because micro-circuitry is just in its infancy. It is the coming thing in electronics. We must develop the Canadian knowhow and we are in the process of doing this. You probably noticed that we have formed a micro systems international company as a subsidiary of Northern. This is the vehicle we are going to use to develop, we hope, micro-circuitry in Canada.

Senator Phillips (Prince): In other words, you are saying that we are really not far behind, but we could drop behind?

Mr. Lester: We could drop behind and we are hoping to develop a facility which would not only be Canadian, because our market is small here, but which will have a base which can get it into the international market.

Senator Phillips (Prince): Thank you very much, Mr. Chairman.

Dr. J. A. Pearce, Research Administrator, John Labatt Limited: Mr. Lester pointed out that they were doing basic research in the iron alloys. I presume he is in contact with the Department of Mines, Energy and Resources in this area. I was curious as to whether he was aware that work in this was being done at the Atlantic Regional laboratory of National Research Council?

Mr. Lester: I am not aware of that; I am glad to know it.

Dr. Pearce: This is the point that we make, that these things happen and unless you are right on top of it you are not aware of these things. I happen to have the NRC's report for last year and they mention that they are doing studies on iron silicate glasses and so on, also studies on iron carbon alloys and studies on iron sulphur alloys. Unless you are sitting there all the time you do not know it. Our point that Dr. Hall made was that if these were consolidated in some way so that you could go to one central point you could pick these things up.

The Chairman: We will come back to this later on, but in order to proceed with some order tonight, Senator Cameron was on my list.

Senator Cameron: Mr. Chairman, this last comment generated by our friend on the end here gives me a chance to mention something I have not mentioned for a week. That is the need for a national inventory of what is going on in Canada. We have been asking for this for a long time.

The Chairman: I knew it would come up.

Senator Cameron: We have not got a picture of what is going on. I quite agree with you that some people say it cannot be done, that there is too much. Have you any comment on that?

Dr. Pearce: No, I would not agree that there is too much; I think it can be done.

Senator Cameron: That is my feeling, but I am a novice in this case.

Mr. Lester: Could I agree with Dr. Pearce in this. I think that if you do not start doing it now it is going to get beyond us. The rate of production of these things is tremendous. Some way or other this thing has got to get down to a computer data bank somewhere, so that people know how to get it.

The Chairman: I am sure you are aware of the Tyas study, which was published about a month ago recommending a kind of national centre on the formation of science technology?

Dr. Pearce: Right.

The Chairman: Do you agree with their main recommendations?

Dr. Pearce: In general I agree with their main recommendations. I think it was a study that was somewhat narrow in its point of view and I feel it should form a base for a much more comprehensive study of the interconnection of scientific innovation. I think it was a very good base. I cannot criticize the effort that was put into it, except to the extent that it was limited in my view.

The Chairman: How would you expand it?

Dr. Pearce: In attempting to expand this kind of communications centre you really have caught me over a barrel because I am not a specialist on this. I believe that the interlock that Senator Cameron raised of the inventory must be given more precedence. You can accumulate a great deal of data and say there it is, but to my way of thinking this left out the interrelationship that should exist. We can only determine after we have had the inventory of the things that are going on. As I say, I am not an expert in this field. I think Mr. Lester probably should be the better man to fill in here.

Mr. Lester: I am by no means an expert, Dr. Pearce, but I was in on some of the earlier discussions when Dr. Hunt was invading this thing. I agree with what you say. This is really a problem of computer programming and cross filing. Until you have the inventory I agree you cannot get the cross index, but you must continually develop the inventory and try to do the cross filing at the same time, otherwise you get lost. These major computer programs, people feel as if you get something on a computer but it takes you years to get a computer program going. We have a number of big ones in Bell and they take anywhere from three to seven years to get really in operation. This is the kind of thing we are looking at. It is not something you get tomorrow. There is a major amount of manpower required to expand the thing. This is skilled manpower too.

Senator Cameron: Could the witnesses give us some indication of how they think this might be done? I think it is crucial to our whole evolution of a science policy to have a national inventory of what is going on. I have been rather discouraged by some of the reactions we have had from some witnesses. They have said you have got such a massive amount of information that you cannot do it. I do not believe that. Maybe this is the conviction of ignorance, I do not know, but I gathered from the comments here that you think this can be done on a selective basis, shall we say. What machinery would you envisage as being necessary to make this a viable operation?

Dr. Pearce: If I may speak to that, senator, I think the people may have avoided the question because it came at them cold. I would not want to avoid answering your question, but I would like to say to you that having placed the question with me I would like to give it some thought and give you a detailed consideration. I feel it can be done, but it needs a little more thought than I could give you in a short evening.

Mr. Cronyn: And should be done.

Senator Cameron: I am sure the committee would welcome that.

The Chairman: Especially the vice-chairman of the committee. We are all vitally interested in this.

Mr. Lester: I would suggest to you, senator, that the basic thing in organizing this would be to establish what we would call a systems planning organization of some sort. If you start in by collecting data you are lost. You must develop a system that knows what it is you are going to do. I think this is Dr. Pearce's point of inter-connection. This is what takes most of the time in actual fact. I would picture that this is something that requires anything up to a hundred really high priced people, or highly skilled people in this computer and data collecting field, to establish the plan. The processes of programming and so on are becoming much more routine these days. This cannot be done at a much faster pace, but I would certainly think that you would have to have a core and not a small core of highly skilled people. Then you would need a task force possibly for several years, I would be just guessing, but for two or three years before you can get this thing off the ground.

Senator Bourget: Do you know if it is being done in other countries?

Mr. Lester: As far as I know, sir, it is not done yet. I do know that I had some conversations with departmental officials about some thought of international data banks of the same general type. This would be even more complicated I would think. No, I do not think it is done anywhere as far as I know. It is probably done; I am sure it is done within particular industries, but not on a national basis that I know of.

The Chairman: The Russians have done a lot of this, not in the complete way that Senator Cameron is envisaging, but at the international level.

Mr. Lester: I think this is right, sir, but mostly from the standpoint of getting it translated into Russian. They have got computer translations from English and German into Russian, which is something we have not got in reverse manner. They get their technical documents translated this way. If they can sort it out into idiomatic Russian they can get a file. I doubt whether they have got an indexed file on it.

Senator Cameron: Would you think then that this might be one of the legitimate recommendations of our committee on science policy, that we should see that this kind of a program is initiated?

Mr. Lester: Far be it from me to anticipate your recommendations, sir, but I certainly think it is an area that needs a lot of work done on in Canada.

Senator Cameron: We have had countless suggestions from witnesses that there is a tremendous amount of duplication in the research work that is going on in government services and in universities and so on. Nobody knows what is going on, so it is an inefficient operation. While I am not excusing what may be happening, it seems to me that if we had this overview of what is being done in Canada we could much more easily avoid duplication in departments throughout the government.

Mr. Lester: Yes, I think so. You are not going to avoid it altogether. In fact, I do not think you should avoid it altogether. There is some competition in this thing, which is useful.

Dr. Hall: On this question of duplication, if I may be so bold as to say I think this is a criticism of research which is not necessarily justified. Let us say there are five different universities in Canada working on the same problem, in quotes. People say this is being duplicated. Mind you, what is the purpose of doing research in the universities? We mentioned before some of the purposes of university basic research. Secondly, the person who is doing that research let us say at university A is a biophysicist, in university B he may be a biochemist, in university C a pure physicist. They approach this same problem from many different points of view, but it is the same problem. They get shifted off on to different tangents and come out with all sorts of different answers at the end. If one made the bold statement that this was duplication

and should be prevented, we would not get very far in science or in the social sciences for that matter. We have to remember the background.

The Chairman: We are all for parallelism, but we would like to have a system whereby parallelism would be more conscious.

Dr. Hall: As to Senator Cameron's question about the compilation of information about what is going on, I know it can be done. It has to be done and I think it should be done. I think Canada has a unique opportunity of giving leadership in this field.

Senator Cameron: Good.

Dr. Hall: There is one little point which is always a deterrent in this type of thing. We are all familiar with abstracts of scientific work. There are many, many little thoughts that come out, not in an abstract of the basic idea but a chance remark, phrase or sentence just springs a light bulb as a new idea to somebody else. We must always remember this. Abstracts and the type of information that you can get on a data processing system are not necessarily always the kind of information that we want for the progress of research and development.

Dr. Pearce: No, but it must lead the man back to the original statement where he had the chance remark.

Dr. Hall: I was hoping to get the implication across that even if we had the most perfect system we still have to have our libraries. This is not a replacement for anything else. It is a new facility to expedite the gathering and dissemination of knowledge and information.

Senator Cameron: That is right. Mr. Chairman, I would agree. Dr. Hall's definition of the lack of duplication I think is quite valid. I could argue that this is not duplication in any sense because they are working on the same problem, but from different points of view and will get different answers because they are looking for different answers although it might be related at the end product. However, I want to come back to the universities. We have had several suggestions made before this committee that university training in the scientific fields is not sufficiently close to industry. Earlier in your remarks you said, rightly, that the university people are going ahead and developing or researching in areas of their own interest and so on, regardless of whether it has a direct application. It is new knowledge and new information. We have had this suggestion so often, that university professors are teaching generations of students without having had any, or at least very little experience in industry, that this is one of the reasons that they are not innovation-oriented today to the extent they should be. What is your comment on this?

The Chairman: Before you comment I think that I can recall what was told to us this morning, that McGill, for instance, is now reaching its fifth generation of engineers and physicists or engineers who had never been in industry.

Dr. Hall: Mr. Chairman and Senator Cameron, this is a subject which requires many hours of discussion to get an answer. As briefly as I can, I think that government, industry and the universities each can take a share of the blame for this problem. Some years ago at least one university which I know attempted through industry to get key people in industry to come and do a one year term even in the universities. They would also permit the university professor or associate professor, a senior man to go into that same industry and get himself re-oriented about the realistic facts of life. This one university attempted to do the same thing with some government agencies, but there was a fantastic reluctance to do this. Industry, I can see the point, say we lose the services of a very senior person. The continuity of his work and the young people who are under him are a part of the necessities of our organization. The universities, I believe, are less reluctant to see their people go out. Governments, again, government departments have been somewhat reluctant, at least the two that I approached for this exchange. Without it, Senator Cameron, I do not think we can reach a true realistic approach to research and development in Canada. I think this must come, it should come and I think it would benefit not only the universities but research and development in industry and government as well.

Mr. Cronyn: We would be thoroughly in agreement with that policy. Although we have good and close relations with a number of universities and a good exchange, I think this would be the only way really to get a thorough line of communication going. I think it would be advantageous to both industry and universities to have this exchange.

Dr. Pearce: Has this not occurred with Dupont and Queen's? Are they not effecting an exchange? At one point they were attempting it and I understood it had gone into practice.

Dr. Hall: Mr. Chairman, it has been done successfully in the field of business administration. That in itself is almost a social science. I like to include this as a social science. It is a managerial science, an executive science. Business is much more willing to give people and take people at that level. In the natural sciences and engineering there is this reluctance.

Senator Cameron: I built up a first class business school just on that principle of drawing from business and the universities.

Dr. Hall: I think this should be continued and extended. I think the three elements which are responsible for the R and D in the total field in Canada should recognize their utter dependence. A university scientist usually forgets that there is ever any dollar sign at the end of his research. In order to get that orientation he must go into a competitive business. Many times in government laboratories they do not have that goal or view in mind. In 1969 I do not think we have to continue to do the type of thing we did in the fifties, sixties or forties. The research and development per se in all its industrial, social and government activities is big business nowadays and if Canada is going to survive it has got to recognize these three elements.

Mr. Lester: I certainly agree with everything Dr. Hall has said. I would make just one added comment maybe if it would be useful. I think there is a field for industry to go the second mile with the universities, if I can put it that way, in the way of identifying particular things which may be of a training nature and may be of a research and development nature that the universities can do for them. A university, if you can find the right person, is only too eager to take on a project. I mentioned this University of Toronto business. As some of you may know, we developed a contract with Queens about five years ago for a post-graduate course in basic engineering. It had nothing to do with how you put in a switchboard, or anything of that sort, but the basics of communications. We had found, for example, that there was not any course in Canada and only one in the United States in switching engineering, which is the most important part of communications. Bell has paid the shot on this and as a result we have trained something like 250 young engineers who are now going ahead in our company and all over the continent in the basic sciences of communications. Perhaps more important, we have trained a cadre of faculty in Queen's University to be much more aware of the problems of communications in industry than they ever were before. Now, they have not come into industry, but they have had a group of people of twenty-five to thirty-five years of age who teach, which is different to an under-graduate. They had to be immersed in the industrial problems. Admittedly, you cannot do this with every university, but I do feel that if you can identify particular universities it is useful. We have done this with Nova Scotia Technical who discovered a particular project that they can do that we are interested in. You can get interchange of ideas, even though you cannot get people. It is not a substitute, I agree Dr. Hall, but it is something in this direction.

Senator Cameron: There has been a good deal done on an improvised basis or an informal basis, that is a company and a university has made arrangements. I am wondering whether you think this committee would be justified in recommending the establishment of some formal machinery that would formalize this kind of approach?

The Chairman: Not necessarily formalize, perhaps senator, but facilitate the contacts?

Senator Cameron: Yes, set up machinery that would recognize this as being an essential of our developing economy and industrialization and give it a more important role in the university-business relationships than it has had so far?

Mr. Lester: I would certainly be all in favour of it myself. I think it is something that needs to come and I think it would help.

Senator Yuzyk: We have had suggestions for the establishment of industrial research or technological institutes at some of the universities in Canada to deal with problems of this kind. How would you look upon such an institute at some of our universities?

Mr. Lester: I think Dr. Hall could comment on that better than I. My own personal reaction would be to deal with the faculties that are there first, rather than start something special. There are very competent people in the universities. Let us deal with them and see what they can develop.

Mr. Cronyn: I would agree with that too.

Senator Carter: Senator Cameron has covered half of the question I was interested in, the communication or lack of communication between the industry and university, industry and government and government and university. What I wanted to get the reaction of the witnesses to is an article which I saw in the bulletin put out by the Bonn government, which comes out every week. The latest one has an article about a decision made by the German Science Council in the summer of 1967. It rose out of their realization that constantly increasing specialization is making it practically impossible for any single university, technical school or academy to do effective work in all or even most areas of research. They conceived the plan of dividing scientific research into different categories and assigning specific fields of endeavour to specific universities. This has been done by the German Science Council. They have found some way of working out a system of priorities. The article does not say how they did that, but apparently they have done it. I would like to get Dr. Hall's reaction because of his experience as the head of a university, his experience with universities in general and with the Science Council, as to whether this is feasible in Canada at this time? Are our universities sufficiently advanced that we could do something like this in Canada?

Dr. Hall: Mr. Senator, first of all we must remember that education, in quotes, is a provincial responsibility and the universities of Canada like to feel that they are fairly independent. They do not like to be pushed around, but they can be moulded, very nicely. As an example, this article is quite right, that there is no university nowadays that can be a specialist in everything. They may have to teach a broader basis, let us say, of chemistry, but some universities because of their locality and the proximity of certain industries might develop a lot of people in a good research unit in the field of macro-molecular chemistry, let us say in the petro-chemical industry valley of Sarnia. It is obvious that the university, being aware of these requirements, would take advantage of this and be able to serve that particular community in Canada by making sure that some scientists in the field of macro-molecular chemistry are available. Another university would be in the field of micro-molecular chemistry. The universities in Canada tend to develop fields of real excellence without being told to do so. I doubt it there is a particularly competitive attitude amongst the universities in this respect. One will, for instance, admit quite readily that university A is in a better position to do a particular job better than university B, therefore it would be unwise and indeed unrealistic for university B to simply compete with university A. The money is limited, personnel is limited, and I really believe this is the case in Canada. There is a cooperative spirit, rather than a competitive spirit. Mind you, there is competition for people and grants.

Senator Carter: I was thinking that if we have enough universities specializing in particular fields of scientific research and they become what is sometimes called centres of excellence they in time would gain a sort of international reputation. This would help their staff problem because people would be seeking to get on their staff. They would not have to be searching to fill their vacancies. Surely that would be a much more logical way of going about our research and getting a greater output for the input. Scientific research, no matter how you look at it, boils down in the final analysis to X dollars from the treasury and they have to be split up among medical research and...

The Chairman: Not exclusively from the treasury.

Senator Carter: No, but out of a total of X, Y will go to universities. That is the best way to get the value for our money.

Dr. Hall: I think there are universities in Canada developing within certain spheres of research and teaching areas of excellence. The University of British Columbia, for instance, in its Pacific Research Oceanography, et cetera, and biological research. This is accepted internationally. It would be unwise for other universities to start competing with the University of British Columbia. Also Dalhousie is developing an area of excellence in that field. The University of Toronto has long been in the field of aeronautical engineering. It would be unwise for other universities in Ontario to get into that field. This is being done. Senator Cameron is very knowledgeable about the universities in Canada too, but that is certainly my feeling.

Senator Carter: Germany has been noted for its scientific education, and advancement and research for years. They must have universities like ours, that have specialized in

various things, but apparently with their development at this stage they have just hit on this plan to carry it further.

Dr. Hall: I think if one goes back into the history of the development of universities in Germany and the development of the universities in Great Britain, the United States and Canada, they have two completely different types of background. The university structures are different. The departmental structures are different. The professor in a German university is God Almighty. We do not have that in the English universities.

The Chairman: We have the opposite here.

Dr. Hall: Almost, the youngsters pushing the top fellows around.

The Chairman: We could discuss the problem of universities almost indefinitely, especially with Dr. Hall, who is now a wise man.

Dr. Pearce: Mr. Chairman, I wonder if Senator Carter would like to have a look at this article on German science? It reflects many things which are not dissimilar to the points we are discussing tonight.

The Chairman: I do not think we will make this available to him until all the members of the committee have a copy of it. We have no discrimination in this committee.

Dr. Pearce: That article indicates that Germany wants to restructure, but not only that, they have a problem similar to ours, where the universities are responsible to the Leander or the eleven states. Superimposed is a federal science policy position.

The Chairman: Financed by the provinces mostly.

Dr. Pearce: Financed in part by both, but 60 per cent is government financed.

The Chairman: If I can change the subject for a moment, I would like to ask our two groups of guests tonight how they go at determining their R & D budget? This nice $50 million?

Mr. Lester: As a famous American has said, Mr. Chairman, this is a series of agonizing reappraisals. In the Bell-Northern complex we have two committee groups. We have what we call a product planning committee of department heads, people with long engineering experience in the two companies, who identify or attempt to identify what the market requirement is for communications, what are the needs that need to be developed. They try to arrive at costs at some reasonable business decisions and to make recommendations up the line that such and such a thing should be adopted. Then we have sitting on top of them as it were what we call a research and development administration committee which I have sat on for the last ten years with myself and another vice-president of Bell and two similar people in Northern. These four people are the people who in effect run the R & D program for the two companies in two areas. How big the budget should be, how much money there is available. What the proportion of it must be to the total sales of Northern, which is a measure. What the particular projects are, the amounts that the various departments have got to spend in the particular year. Their second job, and this gets approved twice a year and signed by the committee members, is to take individual projects as they come up. Of course, in our business anyway, you are committing yourself for dollars anywhere up to five years ahead in the R & D. This more junior committee comes up as closely as possible with a formal presentation for approval by this group. If we approve it, then this project goes within Bell and within Northern through the normal approval processes up to the board of directors, if the board of directors' approval is necessary. The project goes into the labs, becomes part of the program. This is the rule of the thing. In terms of how big it is, the electronic industry seems to need somewhere between eight and ten per cent of manufactured sales to be spent on R & D to keep ahead of the game. This is much heavier than most of industry, I think. Chemicals I think is about three to four; I am not sure what other industry is.

The Chairman: What was the origin of this kind of law or rule?

Mr. Lester: Really an identification of how fast the technology is moving, sir, and an adding of one and one really to start off with. By trial and error over a period of years you seem to find this to be about a level that you can live with. The pressure in Canada, in our industry anyway, is the tendency to exceed that because of this barrier of the international border that I am talking about. In order to live financially we cannot get the percentage much above this eight to ten per cent. This sets up an upper limit and what we really have to do is to make sure that the $50 mil-

lion goes as far as possible. This is the job of these committees and obviously of the scientific people in the laboratories themselves. They have an accounting which is checked every quarter and big projects every month, to make sure that the actual expenditures are in line with the estimates.

The Chairman: So at your level you really start with a maximum. Then you receive applications and projects, and then of course you approve them or reject them based on their merit.

Mr. Lester: The sum of the parts is always greater than the whole, sir. This is where the reappraisal comes in. You have to sort out priorities and we do sort these out into one, two and three categories. The ones are things we know we must do, we are committed to. The twos are things that we would like to do. The threes are also the things we would like to do, but they are the ones that fall off first, so to speak.

Senator Bourget: Have you got short term and long term projects?

Mr. Lester: To some extent, sir, but our stuff all tends to be between two and five years away, because there is that much of a lead time to get through the development process, get it tooled up and get manufacture started. For instance, a relatively simple thing like this contempora set that is being advertised all over the place was first started at Bell four years ago. It was two years in the research and development stage. The other two years were taken up in effect in getting tooled up and manufacture started. You have got a long period. No, I would not say that there is much change. Some things, like a major switching system, yes, this is a longer term, but most of them are in the two to four year bracket.

The Chairman: When you get these different applications do the treasury people sit with you?

Mr. Lester: No, they do not really.

The Chairman: You have your budget to start with?

Mr. Lester: I have responsibilities back to our financial people and to our president for how much Bell can afford in effect as to their participation in this thing, because we pay for the major part of the basic research. Northern have the same kind of thing from their standpoint, because they have to sell the products and obviously the development charges have to be lower than the price of the product. They can only sell that product if it is competitive. This sets disciplines, but in effect the representatives of each company on this committee carry with them the views of their financial people. Next they must go back and sell what they have decided to their financial people.

Senator Carter: Does your R and D of $50 million include innovation right down?

Mr. Lester: Yes, sir, right down to the start of manufacture on a full production basis, including the tooling.

Senator Carter: You do not include market research, commercial research in innovation?

The Chairman: Not in the figures which were quoted tonight.

Mr. Lester: Not in these figures. To be super pure there should be something that comes out back of that, senator, but no, it is not included in these figures.

Mr. Cronyn: Mr. Chairman, we operate somewhat along the basis that we have been recommending in our brief, in that we have established corporate policies or corporate objectives, I should say to start with. I should point out at this time that Labatt, although synonymous with beer to most people in the country, really is now a management holding company involved in the production of beer, wine, soft drinks, a great variety of foods. For instance, through Ogilvie we are the largest flour miller in the country and the largest producer of pasta and a number of other food products. We are also in the feed business and one of the biggest cheese makers in the country. We are also in the pharmaceutical-chemical business and in the animal feed business. We have a variety of companies in our holding group. Having established our corporate objectives under this umbrella we expect each company to establish their objectives. Under these objectives they formulate a plan, not only for one year, but for five years. Having done that they then have to come up with, if you like, a science policy for each one of these units as to what they require to achieve their objectives over the next five years. What do they need in the way of research support, development work, which may be done right down close to the market, or research that may be done back at the corporate research centre? They establish

these, work out their plans, then build up a budget from the requirements they think they need to meet their objectives which totalled up would meet the corporate objectives. This, of course, is reviewed by the corporate management committee. Sometimes the amounts required might be too large to stomach in one year. We naturally have to sort out the priorities on a corporate-wide basis. Of course, each unit has established its priority on a company basis. Then we have to look at it on a corporate basis to establish the priorities and set this as the amount of money that we are prepared to spend on research each year.

The Chairman: How do you define your corporate objective in terms of research and development?

Mr. Cronyn: We do not; it is built up from the...

The Chairman: Yes, but at a certain stage you say no or you say yes. You said that all these individual company objectives had to meet the corporate objectives. How do you define, how do you determine your corporate objective at the top?

Mr. Cronyn: Do you mean for science alone?

The Chairman: Yes.

Mr. Cronyn: This is one which has to be established from year to year. We have certain objectives in the way of profit that we hope to make. The expenditures on science are one of the factors that we take into consideration.

The Chairman: Do you try to keep a certain relationship between what you spend for research and development and the volume of sales?

Mr. Cronyn: No, we do not. We try to build it up from the needs of the various operations. They put down what they think their needs are to accomplish their objectives over the next five years. We build it up from the needs. If this happens to be too big for a corporation to stomach in one year we may have to modify it and take the higher priorities first and postpone the lower priorities to another year. We have no magic figure as to percentage of sales.

Dr. Pearce: This is one of the things that I think is so important in any science policy, whether it is in a company or national, that the objectives must be established first. From the objectives of the organization you establish your scientific policy. From your scientific policy you establish your work plan. Then you determine the cost. I think it follows in a logical sequence down through the phases. There is no magic number. It is totally in the national objective or the company objective from which you must arrive at this policy.

Mr. Cronyn: Until Canada establishes its national objectives I do not see how we can have a national science policy. Until we have a national science policy it will be very hard to coordinate the work that the universities and the government laboratories are doing. We have got to start with the objectives of Canada. I have never really seen these spelled out anywhere.

Senator Carter: Do you agree though with the objectives put out by the Engineering Institute, the national objectives for science and technology?

Dr. Pearce: Transportation and communications were the two that stood out. There are many ways to spell an objective out. For example, we have five objectives spelled out by the Economic Council. They are spelled out in a different way.

The Chairman: This is what we call polemics, not priorities.

Dr. Pearce: I think that the engineering council has pinpointed two possible objectives. These I think are still a little narrow in relation to national objectives of the science council which we have reproduced in our brief and which you all have seen. There are five of them. One is the adequate distribution of rising incomes, and all of these things. We must settle on one of these groups. I like the Economic Council's way of spelling out national objectives. If we say these are the national objectives, then we say what is the national science policy to attain these objectives. Then, once we say this is the policy we say what is the working plan to effect this policy. This is how I feel the steps must be taken.

The Chairman: We have two distinct approaches to the same problem here from two individual companies. It is very interesting.

Mr. Cronyn: I do not think the two companies are comparable.

Senator Cameron: If nobody else has a question, I would like to get down from the high policy of the companies to a detail to Mr. Lester, but it relates to something that will affect our policy recommendations. On page 13 in the third paragraph, just a comment:

> Bell Canada sees a great need for intensified R and D in the field of micro-miniaturization in Canada and recommends that the Federal Government give support of R and D in this field extremely high priority.

This is stressed in recommendation No. 11 on page 4:

> . . . we recommend that the Federal Government support a major national research and development effort to ensure that Canadian technology in this field is maintained at a high level.

You are a company spending $50 million on research I think you said, $53 million altogether this year, which is a sizeable budget, but you still think it is necessary for the federal government to allocate money to assist the research and this would be only one of several fields, I would assume?

Mr. Lester: This is a major field, sir, and it is going to affect other things as well as the telecommunications industry. It is going to affect the computer industry, which is a case in which Canada is far behind, as you know. We are importing practically all of our technology in computers from the United States. I feel that it is something that is probably broader than the telephone industry and the telecommunication industry. It is also something that requires a lot of, not fundamental research, but practical research so to speak, to get started. It has got a big getting started cost to really establish the facilities. There are only two big micro-circuit companies in the United States, Texas Instruments and Fairchilds. They are battling a battle of giants on this thing. If Canada is going to get anywhere and is not going to become swamped by imports, they must have a large base. I think this is the real reason for my saying that in order to get that base started then there needs to be government support to really start it.

Senator Cameron: Are you prepared to suggest a formula which might be applied in this case? That is, is it a matching, fifty-fifty per centage with your company?

Mr. Lester: I am not sure, senator, how familiar you are with some of these things. There has been some action taken in this direction, as you perhaps know, with regard to the establishment of this micro-circuits international company. There have been extensive consultations between Bell and Northern on the one side and government departments, chiefly the Department of Industry, Trade and Commerce, on the other. Our hope is that this will permit us, with some government help, to establish this micro-circuits international group as the major base for micro-circuits in Canada. Not that the Canadian market is sufficient to support such an industry, but that we can then get into the international market and get something which will be able to cope with these very large units in the United States. The difficulty really in self-support is that in this kind of thing there is a period of about five years in our estimation before this really becomes a paying proposition. This indicates the necessity of government support.

The Chairman: Do you think that we can play a useful role in a specialized way in the computer industry?

Mr. Lester: I do not know, sir. I really think that the Americans have got so far ahead on the computer industry, if I narrow this to computer manufacture...

The Chairman: Usually we get the distinction between hardware and software. I do not know if it is valid.

Mr. Lester: Yes, it is very valid. I think we can play a useful role in software. I tell my American friends that one Canadian is worth two Americans most of the time but in the hardware I think they are fairly ahead of us and I do not really think we will catch up, except for peripheral inputs. Peripheral equipment can well be, and some of it is being, manufactured in Ottawa for that matter and can be developed. The stake in large companies is so big that I think that the manufacturing has gone faster. I do think that we have some ability in the software field and in what is called the information utility or computer utility field. I think that Canadians can develop a capability there which would be useful in this country. Our needs are quite different in many ways to those in the United States. Our company structures are different across this country. Our banking structure is entirely different.

Our government structure is different. All of these are people who are going to be major users of computer systems. I would think that there is opportunity in the software of systems area for Canadians, rather than in the hardware area.

Senator Bourget: What is your total revenue from exports of your new products that you develop here? Have you got any figures on that?

Mr. Lester: I do not think I would have a division between new and old products, senator. We hopefully start from the base that we have got something that can be utilized overseas. Then we have modifications to this. In the year 1949 Northern's export was approximately $40 million. Most of this required a fair amount of development, no basic research, because it was stemmed on things which were available in Canada, but it had to meet competition and so on. I could not separate the thing, but the total is about in that order. This amount has been doubling every year for the last three or four years. Northern now have about $50 million of orders in addition to that on their books which have not been filled yet in the international field.

Senator Carter: Is your company doing any research on the use of laser beams for communications?

Mr. Lester: Not in our company, no, sir. There is an extensive amount being done in Bell Telephone Laboratories. We may get into this a little further down the line. Lasers are being used, of course, in manufacturing and in surgery. Bell Laboratories developed the laser scalpel for medical use. In communications they are only in their infancy. I would say we will get into laser beams about 1980 for communications, at which time you would be able to get about seven million telephone conversations on a laser beam, which is the theoretical figure.

Senator Carter: Do you know if any research of that type is going on in Canada?

Mr. Lester: No, I do not think there is any, sir.

Senator Bourget: Mr. Chairman, what about the incentive program?

The Chairman: There have been no questions yet on this. We have a very extensive brief in particular from John Labatt on this, which has been presented to the Minister of Industry, but if you want to ask questions go ahead.

Senator Bourget: Would the companies who are with us tonight prefer incentives to tax or subsidies? That is one of the recommendations we will have to make in our report.

The Chairman: This is not an applied question, it is a basic question.

Mr. Cronyn: From our standpoint we would be happy with tax incentives, but I think when you consider a small new company starting up, which has no profit...

Senator Bourget: That is different, but in your case?

Mr. Cronyn: In our case I think tax incentives is the best way.

Senator Bourget: What about Bell?

Mr. Lester: Yes, I would agree, this is the best way.

The Chairman: So that we would need only two government programs: the tax incentives for older and progressive companies, and grants for new companies?

Mr. Cronyn: If we were to go to one simplified system I think this would be the best way to do it. As we point out in our brief, we are very happy with the NRC program of grants. We have had a very good liaison with NRC, very good technical advice and we have found those programs to be very helpful.

The Chairman: But why do you prefer these programs to the others in industry? We have been told, for instance, that one of the reasons why people were more satisfied with NRC grants was that they were supervised by scientists.

Mr. Cronyn: It is the liaison that develops out of those NRC grants, because that really makes a bridge between NRC and ourselves. We get a very good exchange of information as a result of this. That is the reason why I am suggesting that if we go to one system, the IRDIA system, or tax incentive, we would still like to have the opportunity of calling on the appropriate government research centre for liaison officers.

Senator Bourget: I think it is less complicated also.

Mr. Cronyn: Yes, it certainly is.

The Chairman: You prefer to deal with the scientists and engineers than with lawyers and accountants?

Senator Bourget: I do not blame them.

Mr. Cronyn: I am a little prejudiced.

Senator Bourget: I am too.

The Chairman: But when you say here, for instance, that the federal research bodies working in a common field in science and research be combined into a single unit, do you mean that you would integrate all these under the same authority?

Dr. Pearce: In a common field; I think Dr. Hall touched on that earlier.

The Chairman: This was really, I think, when Dr. Hall commented on this or rather on the regulation aspect and the research aspect.

Dr. Pearce: For example, in our immediate past history we have become involved in the cheese making business. Now, we would like to get the information that is available and go to Ottawa to pick up information relating to cheese, which carries back into the milk industry as well, because we have to remember that cheese is really casein and it is a protein. It comes from milk and there are ways to preserve it. So we find if we go to NRC we can learn a great deal about milk proteins, what happens to them and how they behave in milk. If we want to find out about the casein in cheese we must go over to the Food Research Institute. These two organizations do not necessarily know all that is to be known about each other. So we now must chase to another place to find more information. Then when we come to the additives, or things that might be used, we have to go to a third body, the Food and Drugs, where they are working with the additives that will help preserve cheese or extend the life of milk or otherwise stabilize the casein. We feel that these units should be combined to make one, so that when we want information—now, it does not have to be in one place, it can be separated geographically. So you carry it one step further. We get involved in the fats, because of the fats in milk. We make butter and we look for information on fats. So now it is down to two places. You go to the Food Research Institute of the Department of Agriculture, but also you find that fats are being studied in Fisheries Research Board. So it seems to us that if we are going to have an entity in the food and beverage field we should have an entity here that we can go to, where everything is interlocked. There would be a man in this laboratory who would say I am working on phase A. We ask about phase B and he says, well, go to Joe down the hall or he says well, no, sorry this is something that relates to the fisheries people. We do not have all the information here, but we have some reports. The man who is working in the fisheries lab in Halifax, or in the lab in Halifax, it would not be a fisheries lab then because it would be a food institute laboratory that was national in scope, with one central place that you could get information.

Senator Bourget: That will be very difficult to do. You are talking about your company, but you are involving about three or four departments in that. How could you combine, even if they are not established at the same place, that they think it over and let us know about the solution to that?

The Chairman: They are so diversified that they are asking for a super federal department to adjust to your needs perhaps?

Mr. Cronyn: We have a basic question in Canada as to whether research should be done in a department of the government or a federal department. When did this creep in? It crept in somewhere, but really should a federal department be doing research at all?

Senator Bourget: That may be a solution, but try to combine all these.

The Chairman: Let us pursue this and take agriculture, for instance?

Mr. Cronyn: We feel that the Department of Agriculture should be drawing up the legislation which is going to govern agriculture in Canada and should be, if necessary, regulating and policing it and what not. But the research for agriculture should be done in a research centre, or in a group of research centres which are devoted to research and are really not a part of the Department of Agriculture.

Senator Carter: Government institutes financed by government?

Mr. Cronyn: Oh, yes.

Senator Carter: If they are financed by government they would be crown corporations or departments.

Mr. Cronyn: That is right. It is financed by government in the Department of Agriculture

now, but we are saying that it should be in a crown corporation or in a separate research establishment, part of the NRC for that matter.

Senator Carter: One Crown corporation doing all food research?

Senator Bourget: What about the Food and Drugs Directorate? How do you combine all this?

Dr. Pearce: They are a regulatory body and the research there should be in this common entity. That is where the regulatory body should go for its information.

Mr. Cronyn: This we feel would prevent some of the duplication that is going on.

Senator Bourget: I understand your point. I am trying to find a practical way to do it. That is the main point.

Dr. Pearce: I think that it is going to be very hard, but I think it is very important that we press this point.

Senator Bourget: We agree with you entirely. We are looking for solutions and we are not experts. Probably you have given it more thought than we have and that is the reason why we are asking you all these questions. If you do find the solution, let us know.

Dr. Hall: If you compare what the National Research Council is doing in their own laboratories, perhaps if there was an agricultural research council as other countries have, as you know, this might be one way of implementing the thoughts which have been expressed and which I expressed earlier. Why has Canada not got an agricultural research council, like the United Kingdom, like many other countries, which are very successful?

Senator Bourget: But, Dr. Hall, following your reasoning, do you not think it will come out with too many research councils of some kind, in electronics, or some other branches or disciplines?

Dr. Hall: The field of agriculture is a pretty broad field, the same as the National Research Council covers a broad field.

Senator Bourget: What about the recommendations of the Macdonald Report?

The Chairman: They were not dealing with agriculture.

Dr. Pearce: I think we have to be careful of our semantics here, in that the three councils recommended by the Macdonald Report were councils administrating grants.

The Chairman: To support university research.

Dr. Pearce: The council as Dr. Hall refers to it is really referring to the laboratory function that exists under the aegis of...

The Chairman: Research centres?

Dr. Pearce: Yes.

The Chairman: There are so many words in addition, but they always use the word council.

Senator Bourget: And I have so few words in English, Mr. Chairman.

The Chairman: For so many purposes.

Senator Bourget: I have a question about your research staff. Is most of your research staff Canadian-born or do you have to hire outsiders, foreigners for your research staff?

Dr. Pearce: Fifty per cent of our scientific people are professional people who have degrees and are native born and fifty per cent have been born outside of the country. Some of our fields of activity are a little unusual and it does not behoove us in Canada to institute training where you are only going to employ one man. So we have had to pick up some people from other countries. We are fifty per cent Canadian-born and fifty per cent from outside.

Senator Bourget: I suppose with the beer you have to hire some good Germans who know a lot about beer?

Mr. Pearce: Strangely enough, in our beverage science unit we are in a little different position. We have one Austrian, one Englishman and the others are Canadian born. There are three scientists there that are Canadian born.

Senator Cameron: They have been good students.

Mr. Cronyn: I might also say, Mr. Chairman, that all of our brewmasters are Canadians.

Mr. Lester: I would be guessing at percentages, Senator. I would think that in the R and D process, I am leaving out the rest of the engineers in Bell, we would be probably about 75 per cent Canadian and 25 per cent foreign. We do have quite a substantial group

of people, perhaps more in higher proportion in the senior degrees, interestingly enough, who are European born. We have Japanese, Indians, quite a few Germans and so on, people from western Europe. We have, and in this case "we" is mostly Northern, hired quite a substantial number of people from universities and from European firms over the last ten years. There is a problem here, though, and that is that quite a substantial number of these European boys have come to Canada for a few years with the secret goal of going back home and not staying here. This is something that needs some modifying. We would like to see that 75 per cent get higher.

Senator Bourget: Are you losing more that way than you are losing by those who are going to the United States?

Mr. Lester: I would only be guessing. We are not losing a lot to the United States. Every once in a while we lose a star chap who is going to get 50 per cent more salary in the United States and this kind of thing. Our losses to the United States are mostly in the chaps who are anywhere from two to five years service, the people who have not quite found their niche yet and they do some shifting.

Senator Bourget: Is the question of salary very important?

Mr. Lester: The question of salary is important; I would not think it is the most important. I do feel somewhat in line with what I said earlier that the actual content and challenge of the job, the liberty to pursue their own thing, as young people say, in research is a very important factor. One of the problems we have, I think, is to discipline the scientist, if you will, into a program. Research people like to have a scientific playground, I think Dr. Pearce. I am quite sympathetic with this, but it does not mesh in with the money situation. You get some chafing in that respect, but I do not think there is any differentiation in the Canadian and the European in that respect.

Senator Bourget: Are you satisfied that our universities now are producing the kind of qualified engineers and technologists that you need in your research branch?

Mr. Lester: No, sir.

Senator Bourget: You are not?

Mr. Lester: You linked two things together. If you say the satisfactory kind of people to do research and development, I will agree with you. If you say that they are producing satisfactory engineers to do the day by day implementation job, I will not agree with you. While some universities are doing this, many others are tuning all their engineering graduates towards research. There is only a comparatively small number of engineers or of human beings, for that matter, who are tuned for research. They have got a basic facility for it. The ones who are not tuned to research either drop out when they might be very good practical engineers, or they come to us with the idea that they are going to design black boxes for ever. That is not what they are going to do in an operating telephone company. There is something that needs to be done in the university courses to sort out the research potentials from the practical engineering potentials, who perhaps get a bachelor's degree and become good engineers in the operating sense, but not researchers.

The Chairman: Do you make any long-term research, let us say to use a common expression, towards the year 2000?

Mr. Lester: Yes, I have made several projections that far, senator. We have made some projections of this sort and, of course, this is important. We try to do it for five years, ten years and to the end of the century. Some of the figures frighten you, of course. These are tied in with the statistical projections people in Ottawa and this kind of thing, the ideas of development, technological fields. It is fairly simple for the first five years, because anything that is going to be used five years from now has already been invented. Ten years from now, no, because there are things going to happen between now and then and, of course, thirty years from now you are out in the blue. We have made several projections, yes. Our guess is, and it is only a guess, that the number of telephones in the country is approximately doubling every ten to twelve years. This has been the practice for the last four decades. If this happens, then the mathematics are very interesting by the end of the century. The technological business, the wired city concept, full television business, picture phones are going to be a fact by 1975, not so much to see your wife on the phone, but to be able to get data from a computer, which is the most important use they are going to have.

Senator Bourget: Do you think TV on telephones is going to be accepted?

Mr. Lester: Primarily by business people, senator. We are going to have an in-house trial starting this fall.

The Chairman: Not Members of Parliament?

Senator Carter: Do you see anything getting cheaper in your crystal ball?

Mr. Lester: The units get cheaper, senator, but there are more units required and so your total cost goes up.

The Chairman: But I am sure you are very much interested in research on urban problems. We have been told by the main federal agency interested in urban problems, Central Mortgage and Housing Corporation, that in the last fourteen years they have spent $2.7 million on research and development on urban problems. Do you think this is enough?

Mr. Lester: In fourteen years I would doubt it very much, sir. By another five years I would expect we will have one solid urban complex from Oshawa around to Buffalo. It is almost there now. We are going to have one over the full Montreal island and for twenty miles in either direction. Every big city in North America is growing fastest in the area ten to thirty-five miles out. We are going to have, certainly to the end of this century, about four different complexes. We will have the Great Lakes complex which will extend from Quebec through to St. Louis, the so-called Boswash complex, which will go from Boston to Washington and one on the west coast. I think we have got some tremendous problems, all of us, in feeding this area and we have to get at it. No, I do not think it is anywhere near enough.

The Chairman: Do you have any forecast for the consumption of your most popular product, for the year 2000?

Mr. Cronyn: It is going up steadily. We are having a tough time keeping up with the present demand.

The Chairman: Thank you very much, gentlemen. We will have to adjourn now.

The committee adjourned.

APPENDIX 178

BRIEF

TO

THE SPECIAL COMMITTEE

ON SCIENCE POLICY

OF THE SENATE OF CANADA

FROM BELL CANADA

BRIEF

TO

THE SPECIAL COMMITTEE ON SCIENCE POLICY

OF

THE SENATE OF CANADA

FROM

BELL CANADA

Introductory Remarks

Bell Canada is pleased to have the opportunity of submitting a brief on science policy to the Senate of Canada. This issue is of vital concern to all Canadians, and it is our firm conviction that a successful and viable national science effort is a major prerequisite for realizing the almost unbounded potential of this country in the second century of Canadian nationhood.

As one of the largest companies in Canada, one whose job is service to the public, Bell Canada is engaged, both directly and through our subsidiary the Northern Electric Company, in the largest program of industrial research and development in Canada. We are also proud of the record of this Company in raising the level of productivity both in manufacturing and in telecommunications operations by a substantial margin during the last ten years. These efforts will be continued and intensified in order to ensure that the Company can grow and flourish in a highly demanding environment, calling for great innovation and expansion in the operating field and dynamic growth and excellence in the field of technology.

As a Company that is 95% owned by Canadians, and with 97.8% of our stockholders resident in Canada, our research and development effort is largely indigenous,

designed to ensure continued Canadian excellence in the telecommunications field, although we have the advantage, and make good use of, technical information transfer arrangements with the American Telephone and Telegraph Company and Western Electric Company of the United States. Most of the Company's research and development work is carried out through our manufacturing and research subsidiary, the Northern Electric Company, which maintains a central laboratory in Ottawa and branch laboratories in Montreal, Lachine, London, Belleville, Toronto and Ottawa (Advanced Devices Centre). Total personnel employed in these laboratories as of November 1968 were 1,862 of which approximately 1,200 were scientific and technical staff, including 156 with doctorate or other senior degrees in technology.

Our gross corporate R & D program for 1969, including subsidiaries, will be about $50 million. This effort has been expanding rapidly in recent years and will continue to do so. Of this total amount $41 million represents our indigenous Canadian effort, and $9 million covers imported R & D information, and patent licenses.

As requested by your Committee, a summary of our recommendations and conclusions is given at the beginning of this brief, followed by a discussion of the respective issues in the body of the brief.

SUMMARY OF RECOMMENDATIONS AND CONCLUSIONS

1. We endorse the broad goals for a national science policy which have been set forth by the Science Council in their Report No. 4, towards a National Science Policy for Canada.
2. We recommend that greater use be made of joint Government/Industry task forces or committees to study particular problems in science and technology. There is

a great need for a more open and confident cooperation in national planning matters and also an inherent danger that lack of such cooperation may result in a waste of effort or in serious error in judgement.

3. We recommend that continuous effort be exerted to have the major part of Canadian research and development performed by industrial firms.
4. We recommend that each operating Government department should have a knowledgeable staff in the fields of planning and technological R & D as otherwise these departments will be handicapped in dealing with industry on issues which are inherently within their field of activity and responsibility.
5. We recommend that the Science Council continue its role as a high level advisory and coordinating body, assisting the Federal Government in matters of Science policy.
6. The Department of Industry, soon to become the Department of Industry, Trade and Commerce, has played a useful role in promoting increased R & D in industry, and we recommend that these activities continue in the new combined department, particularly in the area of high growth technology based secondary industry.
7. We recommend that the National Research Council should continue to support research in universities but that greater representation from industry and the Department of Industry, Trade and Commerce should be sought in the formation of NRC's research program to the end that greater emphasis be placed on "mission oriented" research.
8. It is recommended that the Federal Government's programs for supporting research in industry be reviewed. While the incentive grants for industrial R & D should continue, we suggest that better terms

should be provided for companies maintaining a high level of R & D without a spectacular annual increase in R & D expenditures. It is further suggested that research work carried out in the social sciences in support of a company's corporate planning effort should qualify for Federal grants in support of industrial R & D.

9. A revision of Canada's Combines legislation is needed. We recommend that this problem be given a high priority, and that due recognition be given in legislation of the need to encourage large corporate entities which have sufficient resources to compete in the international markets. The approach taken by Britain in these matters is of particular interest to Canada.
10. We recommend that Governments, both Federal and Provincial take steps to develop the study of new technological aids in education, in cooperation with industry. This is particularly important at this time as otherwise Canada will not be able to keep up with the rapidly advancing technology in the educational field.
11. The trend towards micro-miniaturization of electronic circuitry will play a major role in revolutionizing present design techniques. For this reason we recommend that the Federal Government support a major national research and development effort to ensure that Canadian technology in this field is maintained at a high level.

1. GENERAL

As an interested party, we have followed closely the proceedings of your Committee and have been impressed with the quality of the various submissions and the complexity of the

policy questions which have to be resolved. We have also found the Fifth Annual Review of the Economic Council of Canada, The Challenge of Growth and Change, and the Science Council of Canada Report No. 4, Towards a National Science Policy for Canada, to be extremely useful contributions towards a better understanding of the issues involved. We are in general agreement with both of these reports and endorse the broadly expressed goals enunciated for a national science policy by the Science Council and the broad economic goals set by the Economic Council. In our opinion, it is essential that within this broad framework of national economic goals a further effort be made to establish more specific planning objectives for R & D in the various industrial fields.

While we support wholeheartedly the importance of a strong indigenous R & D effort as stressed by the Economic Council, it is also important to Canada to make good use of imported R & D. Bell and Northern Electric spend about $9 million annually on such imported R & D, corresponding roughly to 18% of our gross R & D budget. We also have cooperative arrangements with a number of other companies for exchanging patent information. A great deal of information is also obtained through our work in the International Telecommunications Union which is concerned with developing standards for the telecommunications industry on an international basis.

2. GOVERNMENT-INDUSTRY COOPERATION

There is a great danger that Government planning may often be carried quite far with insufficient participation by the industry concerned. With today's advanced technology, it is possible to do a great many things - at a cost, but in a competitive industrial environment, it is necessary to study market conditions, availability of resources, compatability with existing equipment, etc. before deciding on an optimum course of action. It is, therefore, considered important

that industry be more deeply involved in Government planning in the technological field. This may perhaps be achieved with temporary assignments of industry personnel to various Government organizations or through a more extensive use of joint Government/Industry committees or task forces to evaluate specific problems of national significance.

3. INDUSTRIAL R & D

We are of the opinion that a much greater emphasis on industrial research and development will be required to promote Canadian economic growth and would consider that at least 70% of our national R & D effort should be performed by industrial firms. Undoubtedly the Federal Government would need to fund a substantial portion of this R & D, which nevertheless would probably be very profitable in the long run. The remaining 30% of our national R & D effort would then be carried out either as university research or in Government laboratories. In certain fields such as agriculture, it may well be that Government research stations are the most practicable form of R & D organization.

The question of critical size is extremely important to a successful R & D effort. While a basically one-product industry can get by with relatively small laboratories, a much larger R & D organization is required in a very complex industry such as the public telecommunications industry. It is important to achieve a cross-fertilization of ideas and a ready access to expert advice in related fields of research in order to create a successful climate and environment for R & D and innovation and this can best be achieved in a large organization.

We would consider our own R & D organization with a budget of about $50 million to be just barely of critical size in many of its fields of activity. For example, the development of a modern electronic switching system requires the

effort of a team of several hundred R & D personnel and involves serious risk because of the length of time required to develop such a system, the high cost and the ever-present possibility that the system may be made obsolete by new technological breakthroughs occurring in other competing organizations. The integrated system of operations, manufacturing and research within Bell Canada has made it possible for our manufacturing and research subsidiary, the Northern Electric Company, to undertake such major projects but even then it is necessary for the Northern Electric Company to sell to a much larger market than Bell Canada in order to recover the very high R & D cost in some of these major projects.

4. ORGANIZATION FOR SCIENCE AND TECHNOLOGY

A need is seen for a closer coordination of our national effort in the fields of science and technology, but such closer coordination can probably be achieved without a strong centralization of effort in a Department of Science and Technology or some similar body. Rather, we feel it to be important that each of the Government departments have a high level of insight in matters of science and technology pertaining to its particular area of responsibility, thus facilitating cooperative effort with industry.

5. SCIENCE COUNCIL

The Science Council definitely fills a need for a high level coordinating and advisory board to assist the Federal Government in developing policy and making decisions in the science field. A stronger industrial representation on this council would be an advantage. It is also felt that the Science Secretariat should be primarily a secretariat for the Science Council.

6. DEPARTMENT OF INDUSTRY

The new Department of Industry, Trade and Commerce should continue the good work done by the former Department of Industry in supporting industrial R & D in technology. A pronounced need is seen for coordination of this effort with the general recommendations of the Science Council and also for closer integration of efforts with the National Research Council, the Defence Research Board and the various government departments carrying out R & D in specific areas. It is assumed that the new department will carry the main responsibility for any governmental programs to encourage industrial R & D, including the support of major capital projects to foster technological growth. However, in the various specialized fields the Department should be able to obtain specialist assistance from other government departments or from industry.

7. NATIONAL RESEARCH COUNCIL

It is considered desireable that the efforts of the National Research Council be more closely coordinated with other governmental and industrial R & D programs. This could probably be achieved by stronger representation on the NRC's governing body and its committees by the Department of Industry, Trade and Commerce and by industry.

The NRC should continue to support basic research projects in our universities as well as applied research projects in universities when this is practicable without disrupting the major functions of these institutions.

8. GOVERNMENT INCENTIVES

The present system of Government incentives for research in industry is accomplishing its main aim of encouraging more R & D in industry but it is now in need of revision. Under the present system, grants to support current

industrial R & D are only paid for the increase of R & D expense for the current year over the average level of R & D expense during the preceding 5-year period. Clearly, this means that an industrial organization supporting a sustained R & D effort over a period of many years but with a gradual rather than a spectacular rise in expenditures from one year to the next, will receive very little benefit from the program. It is suggested that the grants perhaps should be based on the absolute level of R & D expense rather than on the year-to-year increase. It would also appear desirable for the incentives program to be graduated to encourage industry to maintain a high ratio of R & D to total manufactured sales, related to the average relationship for the particular industry concerned.

We also feel that more research in the social sciences is required. Ultimately all scientific effort should have the aim of enriching our lives, both materially and spiritually, and the need for more studies of the human ecology is particularly important. Thus Bell Canada is, at the present time, supporting an Urban Development Study, performed by the Centre for Urban and Community Studies at the University of Toronto, for the purpose of gaining a better insight into the various factors pertaining to urban growth which we should take into account in connection with the long range planning of telecommunications services in our metropolitan areas. Also, we are conducting a two-year experiment in Ottawa with an information retrieval television system in cooperation with the Ottawa Public School Board, the Ottawa Collegiate Institute Board and the Ontario Institute for Studies in Education. It is noted that our study of urban development does not qualify as admissible R & D for the purpose of incentive grants under the Industrial Research and Development Incentives Act. In our opinion such enquiries should qualify under the Act.

9. COMBINES LEGISLATION

It is of vital concern to Canadian industry that the Combines Act be revised and modernized so that the Act cannot

be used as an instrument to stifle Canadian industrial growth. In major industries, it is today mandatory to be able to compete with the giants in the international market. If our industry is not strong enough to compete internationally, it will probably in the long run also lose its strength in the domestic market. The Committee will be familiar with the changes which have taken place in Britain to encourage the formation of larger and more viable industrial undertakings which can survive in the international market. It is our firm belief that a similar reevaluation of our own combines legislation is called for and should be viewed as a high priority issue.

It is recognized that existing legislation does permit joint undertakings, or mergers, for purposes of export trade. However, since they are not permitted for domestic trade, the whole approach becomes impractical:-

a) From a practical standpoint, it is extremely difficult to separate production between domestic and export markets. Efficiency, the economies of scale, and financial power to cope with international competition derive from a strong domestic base.
b) Ad hoc consortia for international trade purposes have proved to be difficult in operation, expensive, and, in the light of the powerful integrated efforts in other countries, are no longer competitive.

10. EDUCATION

As a company, we are vitally concerned with an upgrading and expansion of Canadian educational facilities in general. We are also concerned about the need for a better utilization of our physical resources for education, as obviously the economic resources of the provincial governments may easily be overstrained. The Economic Council of Canada

in their Annual Review No. 2 pointed up the correlation existing between the national level of education and a nation's economic prosperity, and we think that the importance placed on education in that report is generally shared by everyone in Canada. Not only do we need more and better educated people to support a more sophisticated industrial society, but we are also concerned with education as a means to improve the quality of life and the fulfilment of individuals.

We would like to stress the need for creating centres of excellence in particular fields at certain universities as Canada's resources will not permit us to stretch the available funds to allow too many multiple facilities in the various universities. The use of federal funds to support research in universities can do a great deal to promote such a concentration of effort in special fields at particular universities.

Another important consideration is to obtain a better balance between enrolment in universities and schools of technology. In too many instances does Canadian industry employ engineers to do work which should rightly be done by qualified technicians. A change in thinking on the part of the general public would seem to be required to foster a better understanding of the role of the qualified technician in modern society.

To utilize our educational facilities better, we would recommend that a total systems approach be taken to study this problem. In our view, there is no other way of effectively planning an efficient utilization of our educational facilities and the proper introduction of new approaches to education. It is particularly important that national planning and R & D be done in the field of new technology in education.

Already television is being used to great advantage in some universities and some valuable work has been done in planning computer facilities and information retrieval systems for education. A truly national effort is, however, required in this field.

It is well known that education is now emerging as the single largest industry in all developed nations, and a tremendous R & D effort is taking place, particularly in the U.S. to develop new technology in this field. Thus leading U.S. electronic manufacturers have recently acquired a number of leading text book publishing houses and undoubtedly electronic technology will play an increasing role in the educational field. Unless a national effort is made in this field in Canada, we may be left far behind.

11. GOALS AND OUTLOOK FOR THE TELECOMMUNICATIONS INDUSTRY

The Canadian telecommunications industry will play an exciting part in the future accelerated growth of this nation. While tremendous strides have already been taken in providing high quality telephone and data services as well as television network distribution through almost the entire country, plus a host of other services, we are just at the beginning of the electronic age. Bell Canada is doing some exciting planning for this new age but it stands to reason that the introduction of new services will be gradual because of the costly and lengthy R & D required to develop new and more sophisticated equipment, and because all new developments have to be compatible with the present multi-billion dollar facilities which are already of very high quality.

It may be expected that in the not too distant future the homes and business establishments will require a wide range of telecommunications services such as banking by phone, PICTUREPHONE, meter reading for gas and hydro facilities by telemetering, television and audio programs, etc. which can all be provided most economically over a common public telecommunications network. Other possibilities are legion. The public telecommunications industry can most efficiently provide the information highway for all these services but a very large amount of R & D should be encouraged in the

electronic and computer industry to develop the sophisticated equipment which will be required on the customers' premises to supply these new services.

A very real possibility before the end of this century is the concept of "the virtual city", i.e. people who are physically located far apart may be able to work as an effective team through the medium of the common environment created by sophisticated communications such as the PICTUREPHONE, joint access to computerized files, time-shared computers and similar devices, making it quite unnecessary to insist on grouping all co-workers together in a large office establishment.

Among the major changes now underway in the telecommunications industry is the development of socalled micro-miniaturized circuits to perform all kinds of electronic functions. Several tens of thousands of passive and active components, including transistors, can be packed into a socalled Large Scale Integrated Circuit, the whole process being controlled by computers. This technique when fully developed, will make it possible to provide great redundancy of circuits thus reducing the possibility of circuit failures to almost nil. Bell Canada sees a great need for intensified R & D in the field of micro-miniaturization in Canada and recommends that the Federal Government give support of R & D in this field extremely high priority.

We would also like to mention the increasing use of pulse code modulation (PCM) in modern telecommunications. Up to now voice signals have been transmitted in analogue form, which means that the electrical signals are similar (or "analogous") in form to the original voice signal although these electrical signals will be shifted up or down in frequency to allow us to transmit hundreds of telephone signals over the same facilities. In pulse code modulation, a voice signal - or any type of signal for that matter - is

sampled several thousand times a second and the amplitude of the signal is coded into a digital form, i.e. it is now represented by a series of pulses, e.g. a combination of "0"s and "1"s if a binary system is used. At the receiving end these digital pulses are then unscrambled and the original voice signal is restored. The great virtue of PCM is that the technique is especially suitable for machine language such as for interconnection of computers but it is also ideally suited for equipment built up using the above-described large scale integrated circuits. We are doing a great deal of work in the field of PCM, and a substantial number of early PCM systems are already in service in Bell Canada.

Our efforts in the electronic switching field have already been mentioned. These new machines will enable us to improve our service to our subscribers still further, and a number of these switching systems are slated for installation in all major centres over the next few years. The first office of this kind was installed in Montreal in time for Expo.

The urban distribution problem will receive special consideration in the future, and as already indicated, major innovations may be expected in this field. New transmission media such as buried millimeter waveguide capable of transmitting well over 100,000 simultaneous telephone conversations or more than a hundred television programs offer great prospects and somewhat further in the distance is the use of optical transmission systems such as Lasers via waveguide pipes which will have a capacity of handling far more traffic than even the millimeter waveguide system.

Satellite communications will be of particular value for overseas traffic and for communications to the Far North but will also be of great value for network distribution of TV and radio programs on a national basis. The economic success of a domestic satellite communications system will to a very

great extent depend on how well it can be integrated with the public telecommunications facilities now provided by the common carrier industry. It may, however, be several years before such a system can support itself economically. The Canadian common carrier industry (CN/CP and the Trans-Canada Telephone System) has offered to build this system and integrate it with existing facilities, but Bell Canada and the other common carriers have also expressed willingness to participate in a Crown corporation for domestic satellite communications as proposed by the Federal Government.

Such a system should definitely be built as a step in our nation-building, but it may prove difficult to obtain public financing at this stage in view of the short term economic prospects for the system. As you know, our Company has invested a great deal of effort and money in developing the required technology in the satellite communications field. We have recently completed a prototype satellite ground station at Bouchette in Quebec of a type which is especially rugged for service in the North. This station has now transmitted to and received signals from the Mill Village earth station via satellite. It is ready for further experimental operation. Very recently the Northern Electric Company was selected to provide the transpondor (i.e. the receiving and transmitting equipment) for the very advanced Intelsat IV satellite which will be developed for the Intelsat organization for use in international satellite communications. Several other projects such as the experimental satellite ground station at the Defence Research Telecommunications Establishment, and two very major study contracts on behalf of the Federal Government have also been completed.

In Bell Canada, we will not be content to rest on our laurels as we are only too aware of the need for a still greater effort to stay ahead in the field of technology, but

we do take pride in what has been accomplished to date and feel justified in looking to the future with confidence.

BELL CANADA
February, 1969

APPENDIX 179

RECOMMENDATIONS

RELATING TO A

CANADIAN SCIENCE POLICY

Submitted to the

Special Senate Committee on Science Policy

by

John Labatt Limited
150 Simcoe Street
London, Ontario

April 10, 1969

SUMMARY

OBJECTIVE

The objective of a National Science Policy is to support the attainment of National Economic Goals.

RECOMMENDATIONS

I. That innovation be given greater recognition in Canada's Science Policy.

II. That Canada's Science Policy encompass two areas:

a) Continuing short-term innovative work to commercialize the results of Research and Development.

b) Long-term Research and Development toward greater utilization of Canada's resources.

III. That Canada's Science Policy be capable of being translated into an integrated working plan.

IV. That Canada's Science Policy assure maximum utilization of inventions and developments made by others.

V. To permit effective prosecution of Canada's Science Policy:

a) That federal research bodies working in a common field be combined into a single unit.

b) That Federal regulatory bodies dealing with a common field be combined into a single unit.

c) That Federal regulatory bodies do a state-of-the-art review at regular intervals to bring regulations into line with advances or impending advances in the art.

d) That Federal Government regulatory bodies adopt flexible pricing practices that permit Canadian manufacturers to use Canadian produce for secondary processing in Canada and to be competitive in world markets

VI. That the amount of money allocated for scientific work be determined from a working plan based on the National Science Policy established for the attainment of National Economic Goals.

INTRODUCTION

1. In attempting to establish "the broad principles,......... of a dynamic and efficient science policy for Canada", six questions must be asked:

(a) What are Canada's goals?

(b) How fast do we want to attain the goals?

(c) What is our stock-in-trade, i.e. what have we got to work with?

(d) What can we get from others' stock-in-trade?

(e) How can we remove some of the roadblocks?

(f) How much should be spent for Research and Development?

Each of these will be discussed in turn.

I. THE GOALS

2. It must be recognized first and foremost that science is not a goal in itself but merely a tool for use in the pursuit of goals.

3. The First Annual Review of the Economic Council of Canada (1964) indicated Canada's goals to 1970 as:

(a) Full employment.

(b) A high rate of economic growth.

(c) Reasonable stability of prices.

(d) A viable balance of payments.

(e) An equitable distribution of rising incomes.

The Fifth Annual Review indicated that Canada was falling short of the goals.

4. The failure of science to contribute to these goals was not the fault of the Research and Development phases which, although necessary preliminary stages, in themselves add nothing to economic growth. The succeeding phase, Innovation, which brings new products and processes into use, is the real contributor to economic growth. As a result, the Economic Council recommended that "Innovation" be given greater recognition in Science Policy.

Recommendation

This company heartily supports the recommendation of the Economic Council, and recognizes that this phase of scientific work must be done primarily by industry.

5. The programs of the Canadian Government to increase the necessary preliminary stages, scientific research and development in industry have been the subject of a separate brief which is appended to this present submission. This earlier brief on "Suggestions for Increasing Industrial Scientific Research and Development in Canada" has been submitted to the President of the Treasury Board and the Minister for Industry, Trade, and Commerce.

II. TIMING

6. Innovation, as a part of science policy, becomes a continuing series of relatively short-term projects. In essence, Canada must be continually in the innovative process to assure that the results of Research and Development are contributing materially to our goals.

7. On the other hand, when it is recognized that Research and Development is generally a long drawn-out process and results of value may not be available for the innovation phase for 10 to 20 years, a portion of our Science Policy must be devoted to goals projected twenty or more years hence. This company has participated in a study of National Objectives for Science and Technology being prepared by the Engineering Institute of Canada which we understand will be submitted to your committee and in which we suggested that our goal should be "Development of Canada's Northern and Arctic Regions". Canada's long term Science Policy would then concentrate on the contributing factors that require special study such as transportation, agriculture, water conservation and urban development. The fallout of these long term projects could have earlier immediate uses. For example, if a grain was being developed for use north of the Arctic Circle, and even if this was not attained, some of the varieties developed along the way might push the arable area of the country north by another hundred miles. This expansion in itself would effect a major improvement in our economy.

8. Whether this topic or topics suggested by others become the primary elements of our Science Policy will depend on the findings of the Committee. In any event, the bulk of this long term research should become a function of government laboratories, but industry should be continuously informed of the work to give them the opportunity of developing findings of immediate interest.

Recommendation

In essence then, we recommend that Canada's Science Policy should encompass two areas:

(a) Continuing short-term innovative work to apply the results of Research and Development.

(b) Long-term Research and Development toward greater utilization of Canada's mass of land, water, and natural resources, possibly through an integrated program for the Northern and Arctic Regions.

III. OUR STOCK-IN-TRADE

9. Canada has developed extensive scientific departments in most of her universities through the grant-in-aid program of N.R.C. and programs in other government departments. Projections presented to this committee indicate that by the mid 1970's, there will be two Ph.D's graduating for every job available. If these graduates are to be used to their maximym, every effort should be made, as soon as the Science Policy is established, to encourage the students to enter areas of need to fulfill the Policy. For example, if the Policy centers around Development of Canada's Northern and Arctic Regions, a large number of Social Scientists may be necessary to resolve the problems of living, recreation and use of leisure time under the different climatic conditions. If there appeared to be a shortage of social scientists, persons whose natural interests tend to the related biological sciences might be re-directed into the social science field. The research conducted by the Universities would then automatically be directed toward the support of the teaching activity.

10. The Community Colleges or their equivalent have made great strides toward the training of technicians and technologists needed to support scientific work. Here, too, the students must be encouraged to enter into fields compatible with the National Science Policy, when it has been established. There is little point in allowing large numbers of chemical technologists to graduate if the major need will be agricultural technologists. Most of these students could probably be adapted to either of these fields, particularly if they realized that, upon graduation, they would be entering a field of useful work.

11. It is generally, recognized that Canada's land, water and natural resources are an important stock-in-trade, but these make no contribution to the economy *per se*. They become of value only when they are put to use by people. The economic return from the use of resources is minimal, and places a minimal demand on the skills of the people, when the produce from these resources is sold by the pound. The return is maximized and the maximum use of our people's skills results from the sale of resources as finished goods. The Scientific Policy must be highly integrated with national

goals in establishing priorities for use of our stock-in-trade. For example, if petroleum resources will make a greater contribution to our overall economy by being converted into useful chemicals, such as polypropylene, than the use of the same land for production of a grain to make starch, which may have a lower economic value, then the production of oil to produce polypropylene must have priority.

Recommendation

In essence, we recommend that the Science Policy must be capable of being translated into an integrated working plan leading to attainment of our national goals.

12. One of the major impediments to the application of science is rapidly becoming recognized and is being referred to as the "N.I.H. syndrome", where N.I.H. means "not-invented-here". This syndrome is common to individuals, organizations, and countries. The individual, by nature, rejects the ideas of others generated in areas where they considered themselves expert. As individuals are part of organizations, the individual's attitude can become the organization's attitude. In companies, two additional factors assist in rejection of others' ideas: as an example of one factor, the company may have considerable investment in physical plant and to protect the useful life of the plant they reject the new idea; as an example of the second factor, industry tries to maximize its operations and this can best be done with the familiar, as entering into a new process almost invariably means a period of less than optimum operations. One country may reject another's inventions on the grounds that the conditions in the two countries are different, and fail to recognize specific areas in which the invention may be applied or that innovation based on the invention may be specifically applicable to their country. The United States and Japan are two countries, whose commercial successes can in part be attributed by their being unaffected by the N.I.H. syndrome.

13. In fulfilling our recommendation that Canada's Science Policy should include short term innovative work, some incentive or other device must be included to assure that advantage is taken of the wealth of ideas and inventions that exist in the United States and which, because of similarities between Canada and United States, must be applicable to the present populated strip of Canada that lies just north of the U.S. border.

14. In fulfilling the program for the future, if it should become, for example Development of the Northern and Arctic Regions, some device should be included to assure that our program capitalizes on inventions and developments by the Russians who have been and are faced with problems similar to our own north.

Recommendation

We recommend, therefore, that any Science Policy for Canada be designed to assure maximum utilization of inventions and developments made by others who are able to make major expenditures on research and development.

V. REMOVING SOME ROADBLOCKS

15. John Labatt Limited is interested in foods and beverages. In attempting to proceed with programs in these fields some roadblocks have been encountered that hinder effective prosecution of scientific work, but that may be easily resolvable. It is quite possible that similar roadblocks exist and affect other fields in which we are not active. The following are some examples.

16. First, in attempting to obtain information about government scientific work on foods, one may have to approach three or four organizations: The National Research Council (Biology Division); The Department of Agriculture (Research Branch); The Food and Drug Directorate; and Fisheries Research Board. Any one unit is prepared to give information freely in their own field of expertise. Where a problem may cross several fields, one unit often cannot advise about the other fields and may not even be able to direct the suppliant to an appropriate member of the other unit. As many problems in the broad class "foods" are interlocking a single research and development unit devoted to this work appears desirable.

Recommendation

It is recommended all Federal Government branches or units doing research and development in a common field be combined into a single scientific unit.

17. In the matter of regulations, similar problems exist. In undertaking work on a new food additive or a new feed additive, a suppliant may have to approach both the Food and Drug Directorate and an appropriate branch of the Department of Agriculture. The jurisdiction of the two bodies may not be clearly visible, with resulting delays in decision making. Sometimes decisions may be made by one body at a considerably later time than that from another. Either of these factors can delay experimental work or prevent optimized experimental plans with resulting increases in the cost of experimental work.

Recommendation

It is recommended that all Federal Government branches or units regulating a common field be combined into a single regulatory unit.

18. Some regulations are too antiquated for modern processing. For example, in the brewing field, continuous processing is impending, but the present method of "dipping" by measuring the volume of a batch is incompatible with continuous processing. In the same vein, the definition of distilling and the regulations governing distilleries precludes the improvement in productivity and cost reduction that could result from shipping a concentrated beer for dilution at various distribution points.

19. It is often the practice of regulatory bodies not to make changes requested by one company without consulting the remaining companies in the same industry. As a result regulations tend to be kept in line with the practices of the laggards in the industry. In addition, the practice of consulting all members may prematurely reveal an important development by an aggressive industry.

Recommendation

It is recommended that Federal Government regulatory bodies do a state-of-art review at regular intervals to bring regulations into line with advances or impending advances in the art. This would let aggressive companies accelerate without forcing them to signal their potential improvements.

20. The Economic Council of Canada has brought attention to the fact that Canadian manufacturers are sometimes charged more for Canadian-produced raw materials than competitors in foreign countries. This applies in the fields in which John Labatt Limited is active. Wheat is sometimes offered on the international market at lower prices than those available to Canadian manufacturers.

21. If Canada's pricing practices for domestically-sold produce were more flexible, wheat destined for the production of wheat starch might be sold at a price that would permit its starch to be competitive with imported corn starch. This would provide an incentive to brewers to do research and development on the use of wheat starch in brewing and thereby eliminate the use of an imported product. Similarly, Canadian-made flour cannot compete with flour produced from Canadian wheat, by foreign countries.

Recommendation

It is recommended that Federal Government regulatory bodies adopt flexible pricing practices that permit Canadian manufacturers to use Canadian produce for secondary processing in Canada and to be competitive in world markets.

VI. SPENDING FOR RESEARCH & DEVELOPMENT

22. Inevitably, the Committee will be faced with the questions of the amount that should be spent for Research and Development. Some will suggest that X% of G.N.P. should be spent in the country and that Y% of sales should be spent by any given company. Others will try to relate the expenditures of other countries and support a given fraction as necessary for Canada.

23. It is our opinion that there is only one method for evaluating the amount that should be spent:

(a) Establish our National Goals;

(b) Determine the Science Policy necessary to support these goals;

(c) Establish a working plan to implement the Policy;

(d) Estimate the cost of the Working Plan;

(e) This will be the amount that should be spent. It relates only to our needs and not to numbers calculated from the expenditures others think they need.

24. This presumes a rational Science Policy and a properly developed working plan. For example, a company would be unlikely to spend $1,000,000 in a year on scientific work to develop four new products when the structure of the remainder of the company is such that they can only launch one new product effectively in a year.

Recommendation

It is recommended that the amount of money allocated for Scientific work be determined from a working plan based on the National Science Policy established for the attainment of National Economic Goals.

APPENDED BRIEF

SUGGESTIONS FOR INCREASING INDUSTRIAL SCIENTIFIC RESEARCH AND DEVELOPMENT IN CANADA

John Labatt Limited
October 23, 1968

SUMMARY

OBJECTIVES

Increasing scientific research and development in Canada is one important route toward the objectives of improving the productivity of present processes and of creating new secondary industry based on new products, thereby making the country more competitive in domestic and world markets.

Other benefits result from these objectives, namely:

1. A real rise in the standard of living as a consequence of an increase in production.
2. A better balance of our export-import trade.
3. A fund of scientific know-how and expertise, which would allow Canadian owned and based companies to establish plants or license patents in foreign countries and bring the resultant income back to Canada.
4. A better basis for implementing expertise purchased from other countries.
5. A better basis for providing technical and other aid to the developing nations.
6. An increase in the number of challenging jobs for scientists and others in Canada.

SUGGESTIONS

BASIC OR FUNDAMENTAL SCIENTIFIC RESEARCH	Adequately handled by government and universities at present. Industry's requirements are: (a) A continuing flow of fundamental knowledge. (b) A continuing flow of scientifically trained manpower.
APPLIED SCIENTIFIC RESEARCH AND THE NATIONAL RESEARCH COUNCIL'S INDUSTRIAL RESEARCH ASSISTANCE PROGRAM	The National Research Council is to be complimented and commended on its IRA (Industrial Research Assistance) program. This program would be still more effective if the period of the grant for any one project were extended from five to ten years and if the grants were made for new scientific research without regard to the requirements for additional scientific staff. Having learned of industry's scientific problems and activities, the Government, by contracting some in-house programs to industry, would give added impetus to the expansion of industrial scientific research in Canada. Great emphasis should be placed on programs for converting waste products, e.g. straw, whey; and raw materials, e.g. minerals, grains and forest products, into consumer products.
DEVELOPMENT AND THE PROGRAM FOR THE ADVANCEMENT OF INDUSTRIAL TECHNOLOGY	A current Canadian weakness is industry's failure to accept the responsibility for translating research discoveries into practice. The following might improve the effectiveness of PAIT (Program for the Advancement of Industrial Technology) and increase development in Canada: (a) Revising Clause 5 of Schedule A of the PAIT agreement, as noted in Appendix B of this brief.

(b) Making PAIT assistance available for amounts approaching 100 per cent of the cost of materials and special equipment needed for the project.

(c) Encouraging government departments to plan far enough ahead to permit contractors to use PAIT to build up needed know-how.

(d) Government departments that have made findings of significance to industry ought not to try to do the development work but should encourage such work by the appropriate industry.

A GENERAL INCENTIVE -- THE INDUSTRIAL RESEARCH AND DEVELOPMENT INCENTIVES ACT

Because IRDIA (Industrial Research and Development Incentives Act) is so recent, only limited comments can be made.

It is recommended that the IRDIA grant of 25% be given to Canadian controlled and based companies and to foreign companies that operate on a world-wide basis from a Canadian base, for all research and development in any one year, regardless of expenditures made in prior periods, or alternately, that the IRDIA program be expanded to provide an additional 25% incentive grant on the first $250,000 expenditure in any one year.

IRA, PAIT AND IRDIA

If grants in aid of industrial scientific research and development must be consolidated into one program, we would recommend a pattern of support along the lines of IRDIA but suggest that liaison officers be made available from the appropriate government research establishment to the grantees at their own request.

SOME BACKGROUND COMMENTS

1. To achieve the objectives outlined, it would seem that Canadian owned (i.e. more than 50% of the equity is held in Canada) and based companies and foreign companies that are prepared to operate on a world-wide basis from a Canadian base should get the major support so that the maximum benefits both in Canada and outside Canada, accrue to Canadians.

2. To emphasize this point, let us take the case of a foreign owned company operating in Canada and taking advantage of the various incentives provided by the government. Let us suppose it comes up with a new product or process which it patents in Canada and elsewhere. It will probably produce in Canada to supply the Canadian market only, with the bulk of the production being carried out elsewhere. If it sublicenses in other countries, the royalties will flow not to the Canadian subsidiary, but to the parent company in another country. In other words, any benefits, either tax-wise or in increased employment or in accumulation of know-how, will not accrue to Canadians.

3. If the same company was Canadian owned and based, then production, both domestic and for export, would be maximized in Canada, thereby helping employment, the know-how would be retained in Canadian hands, and earnings from manufacture and sale in other countries not competitively served by export from Canada or from royalties would flow back to Canada and be taxable there.

4. While the dollar return to Canada from scientific research work done in Canada is an important feature of any program, there is also a great need for importing foreign expertise into Canada, as we cannot be an isolated island in the modern world of science. This foreign expertise cannot be implemented in a technological vacuum, and to be assured that we do have the capability, every effort must be made to enlarge the present corps of research scientists and engineers in industry. In addition, this corps must be highly innovative and capable of effecting improvements on this imported expertise.

5. The definitions adopted in this brief for the terms "Research" and "Development" appear in Appendix A and are those used in Section 2(2)(d) of the Regulations under the Industrial Research and Development Incentives Act. These are the same as the definitions used by the Organization for Economic Cooperation and Development and by the National Science Foundation. In practice, scientific projects overlap or may be omitted from the areas outlined by the definitions and the following guideline is used from time to time for clarity: "Research" is usually manpower intensive, i.e. it requires a high proportion of money for manpower in relation to the cost of equipment and "Development" is usually capital intensive, i.e. it requires a high proportion of money for equipment in relation to the cost of manpower. (National Industrial Conference Board Report No. SBE 102, p. 40).

6. Canada has three general programs to aid research and development in industry (this excludes special programs such as those especially designed for defence research and development). These are:

a) Applied research may be supported by the National Research Council's Industrial Research Assistance program.

b) The Program for the Advancement of Industrial Technology is designed to support the development of products and processes but not to cover the costs of setting up production.

c) The Industrial Research and Development Incentives Act provides general support to industry for both research and development.

7. Having dealt with these three methods of support over a six-year period, we have experienced the following difficulties in bringing scientific ideas into the market place.

a) For some projects, five years of support under NRC's IRA program has been too short.

b) New research projects are not eligible for IRA support unless additional scientific staff are employed for the work.

c) In the agreement under PAIT, the wording of the requirements for production in Canada is too narrow.

d) PAIT assistance does not fully recognize the high cost of extending industrial research projects from applied research to development.

e) The basis for support under IRDIA is too narrow.

BASIC OR FUNDAMENTAL SCIENTIFIC RESEARCH

8. This highly philosophical aspect of science has been and should remain primarily in the scholarly atmosphere of the universities with certain exceptions, e.g., studies involving highly sophisticated atomic piles, some aspects of defence, and the like, which must be done and are being done by governments. In general, basic scientific research fills the storehouse of knowledge, which industry must use to carry forward its applied work and development.

9. There are several reasons for leaving this field to the universities: it provides scope for the philosophical aspects necessary for scholarship; it is manpower intensive; it is the least costly phase of scientific work (the taxpayer may not agree); and it allows for the turnover in student investigators that is a necessary corollary to the concept "university".

10. It is sometimes necessary for universities to move into the ill-defined area tending toward the applied research, but this should be minimal and applied scientific research should be done primarily in the new specialized technological institutes attached to the universities, government laboratories and industrial laboratories.

11. The fundamental phase of scientific work is receiving increasing support from governments. Industry must develop an increasing awareness and appreciation of the fundamental knowledge coming from the universities and must expect this flow of knowledge to continue. In addition, industry should expect and should assist the universities in providing the basic pool of scientifically trained manpower who can help them put fundamental knowledge into practice.

APPLIED SCIENTIFIC RESEARCH AND THE NATIONAL RESEARCH COUNCIL'S INDUSTRIAL RESEARCH ASSISTANCE PROGRAM

12. In the last twenty years, there has been an increasing awareness of the need for enlarging applied scientific research by encouraging changes in outlook of industry and by establishing technological institutes at the universities. This is being done in several ways: the program of the Defence Research Board for industrial research relating to defence; the NRC Industrial Research Assistance Program; and the recent action of the Department of Industry to establish technological institutes on the campuses of some universities.

13. Of these programs, Labatt has received and benefited from the NRC program and wishes to compliment and commend the National Research Council for the excellence of their program, which, in addition to contributing to the establishment of applied scientific research in many companies, should have added a number of scientists and engineers plus corresponding numbers of technicians to the Canadian work force.

14. The Industrial Research Assistance Program allows five years of support for an applied research project, and the time limitation has been handled with some flexibility, although extensions appear to be limited to one year. There are applied scientific research projects that may need up to ten years of work in this phase, and extending support for these types of projects is desirable.

15. Under the IRA program, the NRC appoints a scientist from government as an advisor to the grantee. Our company has benefited from the exchange of scientific information with the IRA advisor and coincidentally from an increased exchange with other scientists in government laboratories. Without the grant as a common bond there is little reason for a casual exchange of information between industrial and government scientists. Regardless of any similarity in projects in industry and in government, specific projects should not duplicate each other. The exchange also helps to eliminate duplication of projects. The beneficial influence of this collaboration cannot be too strongly emphasized.

16. The IRA program had an excellent goal in trying to increase the number of scientists in Canadian industry by requiring that additional scientists be employed for supported projects. This forced industry to increase the population of the scientific community. This goal should be achieved equally well without this requirement merely by the increased exchange between scientists which strengthens the scientific community. Scientists are anxious to remain in and are readily attracted to strong scientific communities.

Recommendations:

1. The NRC-IRA program might be made even more effective by extending the period of a grant for certain individual projects from five to ten years.

2. The NRC-IRA program might be a more effective means of increasing scientific research in Canadian industry if grants were made for new scientific research without regard to the requirement for additional scientific staff.

3. The view of the President of the National Research Council that some of the Government's in-house projects should be contracted out to industries that have appropriate expertise should be implemented.

4. Great emphasis should be placed on programs to do with consumer products and on processing based on the conversion of waste products, e.g. straw, whey, and on available raw materials such as minerals, grains and forest products, in an effort to promote more secondary industry and thereby more employment.

DEVELOPMENT AND THE PROGRAM FOR THE ADVANCEMENT OF INDUSTRIAL TECHNOLOGY

17. It is essential that successful findings from applied research programs be carried forward without delay through the more costly development stages to scale-up and production. As a rule of thumb, for any one project, the costs in various activities will have the following distribution (Fifth Annual Review of the Economic Council of Canada):

Research -- Advanced Development -- Basic Invention	5-10%
Engineering and Designing the Product	15-20%
Tooling -- Manufacturing Engineering (Getting Ready for Manufacture)	40-60%
Manufacturing Start-up Expenses	5-15%
Marketing Start-up Expenses	10-25%

A country can have a fine applied scientific research program, but it is useless without the vision, energy and resources (both people and capital) in industry to carry successful results through the development stage to their logical conclusion, production. A part of Canada's failure to progress in secondary industry might be attributed to the time and money involved in the various phases of work necessary to put a concept for a production improvement into practice or to bring a product idea to market. This inadequacy in Canada's technological growth has been attributed to:

a) Hesitating to move some industrial projects beyond the applied research stage, and

b) Industries allowing themselves to be convinced that significant findings from applied research are not commercially feasible due to the high cost of development.

18. The PAIT program, which was an excellent initial step toward getting industry to carry favorable findings through the next phase of study, is not attracting industrial development work to the extent hoped for in its present form, and is therefore not accomplishing its purpose.

19. The PAIT program is designed to support the development of products and processes which serve to increase productivity or otherwise contribute directly to economic growth, but not to cover the costs of progression into the production phase. The latter should be done through a company's normal channels for financing their enterprise. From the statistics, and from the small call on PAIT, it would appear that the funds are not being taken up by industry. We have observed two factors that may be contributing to the problem: the wording of the restriction to production in Canada, and the general limitation on development assistance at a stage when the high cost of extending industrial projects may be deterring the move from applied research to development:

I. Schedule "A" of the PAIT agreement makes production in Canada, subject to the discretion of the Minister, a requirement for obtaining assistance. It is unrealistic to expect that a Canadian company will be able to supply the world market economically from a Canadian base, and where material costs, transportation costs, tariff barriers, perishability or the like becomes a problem, the Minister would be the first to recognize a documented need for production from another base. While in Canada the Minister's handling of this requirement is probably understood by the management of companies fully familiar with the Canadian scene, it does affect some companies whose management is normally making contact with less understanding officials in other governments.

Recommendation

A modification of Clause 5 of Schedule "A" along the lines drafted in Appendix B would increase the development work done in Canada.

II. PAIT assistance, designed to support the development stage of research activities, does not provide a sufficient incentive to entice industry to move from the applied research stage to the high cost development stage. The high cost of advancing a program from the applied research stage to the development stage is, in most instances, directly attributable to the fact that development work usually requires heavy expenditures for capital facilities rather than for manpower as in applied research. The NRC-IRA program has implicitly recognized the intensive manpower requirements in applied research and has based its assistance on manpower costs. PAIT assistance based on up to 50% of the total cost of the project fails to recognize the high capital investment required in expanding a project into the development stage. In many instances research teams will have been established during the applied research stage which will be sufficient to carry the project through the development period. Assistance must, therefore, be now more specifically directed to underwriting the heavy expenditures for capital facilities necessary to the development program.

Recommendation

The PAIT contribution for development work, recognizing the high cost of advancing a program from the applied research stage to the development stage, should be adjusted to provide 50% of the cost of manpower and up to 100% of the cost of materials and capital facilities needed for the project. This would be a very specific inducement for a company to move from the applied research stage to the development stage in its research program. It would also enable a company to acquire high cost equipment where little residual value is anticipated on the completion of the development work.

20. In addition to the above recommended changes in the PAIT program, some expansion of the program to overcome the following problem might be considered:

> Some government contracts, both federal and provincial, are let to foreign-owned companies not even operating subsidiaries in Canada because the know-how is not available here. It is recognized that government departments, trying to work within their budgets, wish to buy at the lowest tendered price and to get the earliest possible delivery date. While this goal is commendable, governments must differentiate between the narrow aim of running a government department at low cost and the broad aim of building up the country by increasing Canadian technology and know-how. Government departments know their needs well in advance and could and should plan their requirement to maximize the use of Canadian industry. When a need is planned far enough in advance, the Department of Industry is in a position to arrange for development work on contracts called by other federal government departments and by provincial government departments.

Recommendation

Federal Government Departments should plan their requirements sufficiently far ahead to permit development work on contracts for which know-how must be built up in Canada and should encourage Provincial Government Departments to do likewise, thereby increasing secondary industry and enlarging Canadian expertise.

21. Some government departments complete applied research programs and then continue with the development program in an attempt to give industry a completed package. Unfortunately, research scientists in general and government research scientists in particular, are not development oriented and do not understand the practical problems of converting a scientific finding into a productive operation.

22. These government departments should call in the appropriate industrial groups as soon as an interesting finding is made, work with them as the project is carried into the development stage and then let industry take the finding from development into production. Industry may finance the development work from its own funds or seek PAIT assistance.

Recommendation

Government departments, whose research results are of significance to industry, should call in the appropriate industry immediately and encourage them to do the appropriate development work, which industry may finance from their own funds or with PAIT assistance.

A GENERAL INCENTIVE -- THE INDUSTRIAL RESEARCH AND DEVELOPMENT INCENTIVES ACT

23. IRDIA, which was designed to replace the general scientific research and development incentives offered to industry by the Income Tax Act, has been in operation only for a short period. In essence, the IRDIA program allows a tax rebate or cash grant equal to 25% of expenditure in any one year in excess of the average expenditures made by the company in the preceding five years. While the general program is effective, its principle could be extended to provide even greater acceleration of research and development activities in Canada.

24. In Canada there are, of course, many companies engaged in research and development. About 800 Canadian companies reported R & D expenditures for 1965, and it would appear that fewer than 20 companies performed half of the work done in industry (Fifth Annual Report of the Economic Council of Canada). What is significant is that, by and large, most of the firms engaged in some sort of scientific research and development are spending less than $100,000 per year and many medium-sized companies are operating within research budgets of under $250,000 per year. Most of these companies are Canadian owned and based and their rate of expansion of research and development is slow, and hence the incentive offered by the present IRDIA program is only of limited value. A more active expansion could be accomplished by allowing an incentive grant for all research and development regardless of the expenditures made in prior periods. The Economic Council of Canada has presented a somewhat similar recommendation in its publication, "A General Incentive Programme to Encourage Research and Development in Canadian Industry" on Page 13.

Recommendation

A general research and development incentive should be made available to Canadian owned and based companies and to foreign companies that operate on a world-wide basis from a Canadian base, amounting to a 25% tax credit or cash for all expenditures for research and development regardless of the expenditures made in prior periods.

25. The foregoing recommendation is consistent with the thesis expressed in Para. 1 and is our favored recommendation, but there is an alternative:

Alternate Recommendation:

Consider expansion of the IRDIA program to allow an incentive grant on the first $250,000 expenditure for any one year on scientific research and development regardless of the expenditures made in prior periods. This would act equally as a stimulus to all companies and encourage the rate of growth of research and development activities generally. Most notably, such a scheme would assist smaller firms where the incentive grant based on expenditures over and above a base amount is viewed as only minor assistance of a temporary nature.

IRA, PAIT AND IRDIA

26. In discussions of increasing industrial scientific research and development with a number of interested persons, the relative merits of the NRC-IRA program, the PAIT program, and IRDIA, and their possible consolidation, has often come to the fore. As each was designed for a specific purpose and as comparisons are difficult, the views expressed were primarily subjective.

27. In our opinion, if we were to adopt only one form of incentive to encourage the expansion of scientific research and development in Canada, the IRDIA program is the most desirable, and would become even more desirable if it included the extensions recommended in paragraphs 24 and 25. The rationale for this statement is the general applicability of the program regardless of other conditions such as the net increase in scientific staff (IRA) or the minimum annual effort of one professional man year (PAIT).

28. The PAIT program provides limited incentive to the intermediate-sized and small company. It is not an attractive vehicle for financing small or medium-sized development projects, and, in fact, a company's financial status must be found accepta ble before PAIT assistance is even given. The real value of PAIT lies in its "insurance underwriting" aspect. Insurance is of primary importance to those few firms engaged heavily in research and development where relatively high-cost development projects are undertaken. The small and medium-sized companies require an assistance program which provides a subsidy and/or low-cost financial assistance rather than "insurance" coverage. This can be achieved by implementing the recommendations for extending IRDIA in paragraphs 24 and 25.

29. Although an extended IRDIA program may be the best of existing methods for expanding scientific research a nd development in Canada, Labatt, as a company, would prefer to see the NRC-IRA program continued for the reasons noted in paragraphs 12 to 15.

Recommendation:

If grants in aid of industrial scientific research and development must be consolidated into one program, we would recommend a pattern of support along the lines of IRDIA but suggest that liaison officers be made available from the appropriate government research establishment to the grantees at their own request.

APPENDIX A

Definition of Scientific Research and Development from Regulations Under the Industrial Research and Development Incentives Act

The following definition is an extract from Section 2(2)(d) of the Regulations:

> "Scientific research and development" means systematic investigation or search carried out in a field of science or technology by means of experiment or analysis, that is to say,

(i) basic research, namely, work undertaken for the advancement of scientific knowledge without a specific practical application in view.

(ii) applied research, namely, work undertaken for the advancement of scientific knowledge with a specific practical application in view, and

(iii) development, namely, use of the results of basic or applied research for the purpose of creating new or improving existing materials, devices, products or processes,

and where such activities are undertaken directly in support of scientific research and development, includes activities with respect to engineering or design, operations research, mathematical analysis or computer programming and psychological research, but does not include activities with respect to

(iv) market research or sales promotion,

(v) quality control or routine testing of materials, devices or products.

(vi) research in the social sciences or the humanities,

(vii) prospecting, exploring or drilling for or producing minerals, petroleum or natural gas,

(viii) the commercial production of a new or improved material, device or product or the commercial use of a new or improved process,

(ix) style changes, or

(x) routine data collection.

APPENDIX B

PAIT AGREEMENT

SUGGESTED ADDITION TO CLAUSE 5 OF SCHEDULE "A"

(5) So long as the process or product resulting from the project is being used or produced in Canada to supply the Canadian market and to supply those export markets that can be served competitively from Canada, the Company shall have the right to produce outside of Canada in areas that cannot be served competitively, or the right to license a person, company, partnership or firm in such areas to use the technical data, inventions, methods and processes resulting from the processes.

The Queen's Printer, Ottawa, 1969

First Session—Twenty-eighth Parliament
1968-69

THE SENATE OF CANADA

PROCEEDINGS
OF THE
SPECIAL COMMITTEE
ON

SCIENCE POLICY

The Honourable MAURICE LAMONTAGNE, P.C., *Chairman*
The Honourable DONALD CAMERON, *Vice-Chairman*

No. 75

THURSDAY, JUNE 26, 1969

WITNESSES:

Dr. Mabel F. Timlin, Emeritus Professor of Economics, University of Saskatchewan, Saskatoon, Saskatchewan; Dr. H. Edward English, Director, School of International Affairs, Carleton University, Ottawa, Ontario; Dr. Julius Lukasiewicz, Professor and Associate Dean for Research, Virginia Polytechnic Institute, College of Engineering, Blacksburg, Virginia, U.S.A.; Professor F. Eric Burke, Department of Management Sciences, University of Waterloo, Waterloo, Ontario; Mr. J. Mardon, Technical Director, Pulp and Paper Group, Major Forest Products Company; Mr. J. Root, President, R-O-R Associates Limited, Toronto, Ontario; and Dr. E. Jantsch, Consultant, OECD.

APPENDICES:

180—Brief submitted by Dr. Mabel F. Timlin.
181—Brief submitted by Dr. H. E. English.
182—Brief submitted by Dr. Julius Lukasiewicz.
183—Brief submitted by Professor F. Eric Burke.
184—Brief submitted by Messrs. J. Mardon and J. Root.

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MEMBERS OF THE SPECIAL COMMITTEE

ON

SCIENCE POLICY

The Honourable Maurice Lamontagne, *Chairman*

The Honourable Donald Cameron, *Vice-Chairman*

The Honourable Senators:

Aird
Bélisle
Blois
Bourget
Cameron
Carter
Desruisseaux
Giguère
Grosart
Haig
Hays
Kinnear
Lamontagne
Lang
Leonard
McGrand
Nichol
O'Leary (*Carleton*)
Phillips (*Prince*)
Robichaud
Sullivan
Thompson
Yuzyk

Patrick J. Savoie,
Clerk of the Committee.

ORDERS OF REFERENCE

Extract from the Minutes of the Proceedings of the Senate, Tuesday, September 17th, 1968:

"The Honourable Senator Lamontagne, P.C., moved, seconded by the Honourable Senator Benidickson, P.C.:

That a Special Committee of the Senate be appointed to consider and report on the science policy of the Federal Government with the object of appraising its priorities, its budget and its efficiency in the light of the experience of other industrialized countries and of the requirements of the new scientific age and, without restricting the generality of the foregoing, to inquire into and report upon the following:

(*a*) recent trends in research and development expenditures in Canada as compared with those in other industrialized countries;

(*b*) research and development activities carried out by the Federal Government in the fields of physical, life and human sciences;

(*c*) federal assistance to research and development activities carried out by individuals, universities, industry and other groups in the three scientific fields mentioned above; and

(*d*) the broad principles, the long-term financial requirements and the structural organization of a dynamic and efficient science policy for Canada.

That the Committee have power to engage the services of such counsel, staff and technical advisers as may be necessary for the purpose of the inquiry;

That the Committee have power to send for persons, papers and records, to examine witnesses, to report from time to time, to print such papers and evidence from day to day as may be ordered by the Committee, to sit during sittings and adjournments of the Senate, and to adjourn from place to place;

That the papers and evidence received and taken on the subject in the preceding session be referred to the Committee; and

That the Committee be composed of the Honourable Senators Aird, Argue, Bélisle, Bourget, Cameron, Desruisseaux, Grosart, Hays, Kinnear, Lamontagne, Lang, Leonard, MacKenzie, O'Leary (*Carleton*), Phillips (*Prince*), Sullivan, Thompson and Yuzyk.

After debate, and—
The question being put on the motion, it was—
Resolved in the affirmative."

Extract from the Minutes of the Proceedings of the Senate, Thursday, September 19th, 1968:

"With leave of the Senate,
The Honourable Senator Lamontagne, P.C., moved, seconded by the Honourable Senator Benidickson, P.C.:

20674—1½

That the name of the Honourable Senator Robichaud be substituted for that of the Honourable Senator Argue on the list of Senators serving on the Special Committee on Science Policy.

The question being put on the motion, it was—
Resolved in the affirmative."

Extract from the Minutes of the Proceedings of the Senate, Wednesday, February 5th, 1969:

"With leave of the Senate,
The Honourable Senator McDonald moved, seconded by the Honourable Senator Macdonald (*Cape Breton*):

That the names of the Honourable Senators Blois, Carter, Giguère, Haig, McGrand and Nichol be added to the list of Senators serving on the Special Committee on Science Policy.

The question being put on the motion, it was—
Resolved in the affirmative."

ROBERT FORTIER,
Clerk of the Senate.

MINUTES OF PROCEEDINGS

THURSDAY, June 26, 1969.

Pursuant to adjournment and notice the Special Committee on Science Policy met this day at 10.00 a.m.

Present: The Honourable Senators Lamontagne (*Chairman*), Belisle, Blois, Cameron, Haig, Grosart, Kinnear, Phillips (*Prince*), and Yuzyk—(9)

In attendance: Philip J. Pocock, Director of Research (*Physical Science*); Gilles Paquet, Director of Research (*Human Science*).

The following witnesses were heard:

Dr. Mabel F. Timlin, Emeritus Professor of Economics, University of Saskatchewan, Saskatoon, Saskatchewan.

Dr. H. Edward English, Director, School of International Affairs, Carleton University, Ottawa, Ontario.

Dr. Julius Lukasiewicz, Professor and Associate Dean for Research, Virginia Polytechnic Institute, College of Engineering, Blacksburg, Virginia, U.S.A.

Professor F. Eric Burke, Department of Management Sciences, University of Waterloo, Waterloo, Ontario.

Mr. J. Mardon, Technical Director, Pulp and Paper Group, Major Forest Products Company and,

Mr. J. Root, President, R-O-R Associates Limited, Toronto, Ontario.

Dr. E. Jantsch, Consultant, OECD.

(*A curriculum vitae of each witness follows these Minutes*)

The following are printed as Appendices:

No. 180—Brief submitted by Dr. Mabel F. Timlin.
No. 181—Brief submitted by Dr. H. E. English.
No. 182—Brief submitted by Dr. Julius Lukasiewicz.
No. 183—Brief submitted by Professor F. Eric Burke.
No. 184—Brief submitted by Messrs. J. Mardon and J. Root.

At 12.55 p.m. the Committee adjourned to the call of the Chairman.

ATTEST:

Patrick J. Savoie,
Clerk of the Committee.

CURRICULUM VITAE

Burke, F. Eric: Associate Professor, Faculty of Engineering, University of Waterloo since 1967, now in Department of Management Sciences. B.A. (London) 1945, M.Inst. Mech. Eng. (U.K.), C. Eng. (U.K.), P. Eng., (Ontario). After five years industrial experience in development engineering and process equipment design, and a further five years with technical and scientific consultants in the U.K. he came to Canada in 1952 and joined Can. G.E. in Montreal. While Manager, Materials Research Laboratory, 1956-67, Canadian General Electric Company, Toronto, Professor Burke has directed applied research into thermal and physical properties of high-strength polymer composites, electrical discharge phenomena and their detection, and di-electric materials ageing, resulting in more than 20 major internal reports, his assistance in the direction of several U.S. (G.E.) projects, and invited lectures at M.I.T. and the National Academy of Sciences. He was formerly a consultant to Corporate Management in New York of the General Electric Company, on strategies and organization for research and development. He is the holder of patents in connection with electrical-mechanical-chemical processes and devices, and presently holder of a major Killam Award from the Canada Council for research in "Types and Processes of Innovation, Technical Change and Society". His current research interests include empirical determination of utility functions, human and physical information limits, organization theory under conditions of high information loads. He is a consultant to various governmental and private agencies on Science Policy, Manpower Planning, and Research and Development Policy. He also serves as a Lecturer in Mechanical Engineering at the University of Toronto, in a graduate seminar on heat transfer with change of phase. His articles and papers include: "The Theory and Practice of Tensile Elongation Measurement" S.P.E.J., (1963); "Partial discharges with non-symmetrical electrode pairs" (with E. A. Atkinson); *Proc. Diel. Conf.* (1963) National Academy of Science/National Research Council; "Science and Government, the Users' Viewpoint". CBC Feb. 1966 (mimeo). "Compromize Fuel Batteries—a benefit/cost analysis" 2nd. Canadian Fuel Cell Symposium, Montreal, Sept. '66 "Notes towards a general theory of innovation", Department of Management Sciences (mimeo), (1965); "Interim report on the Killam Award project 67-0157", Department of Management Sciences (mimeo), (1969); "Logic and variety in innovation processes" in *Technical Innovation and the Growth of the National Economy* Wiley, (in press).

English, H. Edward: Born March 5, 1924. Married to the former Katharine Wilson Cate in New York City, 1949; four children. Primary and Secondary Education: Model School, Oak Bay High School, Victoria, B.C. University Education: B.A. (British Columbia) 1945; Ph.D. (California) 1957. University Employment: 1945-49, Teaching Assistant, University of California; 1949, Appointed to Department of Economics, Carleton University; (1957-58, Sabbatical leave in England and Sweden); 1962-66, On leave from Carleton University to Private Planning Association of Canada, Montreal; 1966-68, Director, School of Commerce, Carleton University; 1967-68, Acting Dean of Graduate Studies, Carleton University; 1968, Director, School of International Affairs,

Carleton University. Other Employment: Currently Secretary of the Private Planning Association of Canada and Director of Research of the Canadian Trade Committee and of the Atlantic Economic Studies Program, 1962; Formerly served on staff of the Royal Commission on Canada's Economic Prospects in 1956; Advisory work for Restrictive Trade Practices Commission and Department of Corporate and Consumer Affairs. Activities and Associations: Member of the Canadian Association of University Teachers; Formerly Chairman of Committee on University Financing, CAUT; Vice-President of Consumers' Association of Canada; Economics Editor, Carleton Library series. Selected Publications: 1. Books—*Transatlantic Economic Community: Canadian Perspectives,* Private Planning Association of Canada, Montreal, 1968. *Canadian Economic Policy,* Chapters 1-3, 6, and 16, Macmillan, Second Edition, 1965. *Industrial Structure in Canada's International Competitive Position,* Canadian Trade Committee, 1964. *Trade Barriers Between Canada and the United States* (co-author with Francis Masson), Canadian-American Committee, 1963. 2. Articles—"The Nature and Efficiency of Canadian Industrial Structure" in *Contemporary Canada,* Duke University Press, 1968. "Japan's Developing Trade Strategy" in *Round Table,* April, 1968. "Manufacturing" in *Canada: One Hundred,* Queen's Printer, Ottawa, 1967. "Automobility—Predicament or Precedent?" in *Canadian Banker,* Summer, 1965. "Scope for Economic Planning in Canada" in *The Business Quarterly,* Fall, 1963. "Canada's International Economic Position" in *Canadian Banker,* Summer, 1963.

Jantsch, Dr. Erich: Austrian theoretical physicist and engineer. Formerly with Brown-Bovary (electro-technics) as theoretical physicist, engineer. Later consultant to management on long-term planning. 1962-68 consultant to OECD on technological forecasting. Author of OECD book on that subject. Now temporarily at MIT studying the future of technological universities and how they can best serve society.

Lukasiewicz, Dr. Julius: Date of Birth: November 7, 1919; Place; Warsaw, Poland. Education and Professional Qualifications—Degrees: B.S. (Eng) London, 1943; D.I.C. (Aero. Eng.) Imperial College, London, 1944; Dipl. Eng., Polish Technical University, London, 1945; D.Sc. (Eng), London, 1966. Other formal education (including fellowships, short courses, workshops, etc.): "Mathematics Review with Emphasis on Modern Developments and Applications to Engineering," University of Tennessee, November 1967.

Membership (current) in scientific and professional societies

Society	Grade	Offices and major committee assignments
AIAA	Associate Fellow	Member, Ground Test & Simulation Committee
CASI	Fellow	Founder Member, Associate Editor Canadian Aeronautics and Space Journal
I Mech E	Member	
New York Academy of Sciences	Member	

Service on VPI Faculty

Date	Rank	Department
June 1968—Present	Professor	Aerospace Engineering
	Associate Dean for Research and Graduate Studies	College of Engineering

Professional Experience—Teaching: Graduate course in "Fluid Mechanics", McGill University, Department of Graduate Studies, Ottawa, 1954-1955. Visiting Lecturer, Department of Engineering and Applied Science, Yale University, April 1965. Visiting Research Professor, School of Architecture, University of Montreal, Montreal, Canada, Jan-May, 1967. Invited Lecturer, University of Tennessee Space Institute Short Course on "High Speed Aerodynamics with Emphasis on the Physics of High Temperature Gases," March 11-21, 1968, Tullahoma, Tennessee. Lectures on "Experimental Hypersonic Research Facilities." Full-time Industrial Experience: January 1945-November 1948, Senior Scientific Officer, Royal Aircraft Establishment, Farnborough, U.K. December 1948-February 1958, Head, High Speed Aerodynamics Laboratory, National Research Council of Canada, Ottawa. March 1958-May 1968, Chief, von Karman Gas Dynamics Facility, ARO, Inc., Operating Contractor for Arnold Engineering Development Center, USAF, Tullahoma, Tennessee. Consulting Work: Consultant, ARO, Inc., operating contractor of Arnold Engineering Development Center, USAF, July 1968-Present. Other: Commonwealth Advisory Aeronautical Research Council, U.K. 1955-58, Canadian Coordinator for High Speed Aerodynamics; 1957-58, Chief Commonwealth Coordinator for High Speed Aerodynamics. Reviewer, Applied Mechanics Reviews, 1956-1967. Chairman, Publications Committee, C.A.I. Journal, 1956-1957. Chairman, Supersonic Tunnel Association, 1961-1962. Chairman and Founder Member, Aeroballistic Range Association, 1961-1962. Member, Fluid Dynamics Panel, Advisory Group for Aeronautical Research and Development, North Atlantic Treaty Organization, 1962-1968. Member, RTD Ad Hoc Group Review Committee, AF Flight Dynamics Laboratory, March 29-30, 1965. Associate Editor (Fluid Mechanics, High Speed), Canadian Aeronautics and Space Institute Journal, 1965-1968.

PAPERS PUBLISHED IN PRINT AND IN PROCEEDINGS OF MEETINGS

Adiabatic Flow in Pipes

Aircraft Engineering, Vol. 19, No. 216, Feb. 1947, p. 55; Vol. 19, No. 217, March 1947, p. 86

Effects of Air Humidity in Supersonic Wind Tunnels

Seventh International Congress of Applied Mechanics, London, September 1948 (see Proceedings, Vol. 2, Pt. II, pp. 633-640)

Shock Tube Theory and Applications

Report 15, National Aeronautical Establishment, Ottawa, Canada, 1952

Development of Transonic Wind Tunnel Technique

(Co-author: J. A. Laurmann)

Summary of Proceedings, Symposium on High Speed Aerodynamics, NAE, Ottawa, February 27, 1953, p. 30

Wind Tunnels in the High Speed Aerodynamics Laboratory

Symposium on High Speed Aerodynamics, Summary of Proceedings, NAE, Ottawa, February 27, 1953, p. 61

Diffusers for Supersonic Wind Tunnels

Journal of the Aeronautical Sciences, Vol. 20, No. 9, September 1953, p. 617

Supersonic Ramjet Performance

Aircraft Engineering, Vol. 25, No. 296, October 1953, pp. 298-306

Drive and Operation of Large, Intermittent Wind Tunnels

Second Canadian Symposium on Aerodynamics, February 25-26, 1954, Institute of Aerophysics, University of Toronto, Toronto, Ontario, Canada (Published in Proceedings)

Development of Intermittent Tunnel Technique

Paper presented at the Fifth Meeting of the Wind Tunnel and Model Testing Panel, AGARD, Scheveningen, May 3-7, 1954, pp. 98-126

Development of Supersonic Wind Tunnel Facilities in Canada

Seminar on Wind Tunnel Techniques and Aerodynamics, Kungl Tekniska, Hogskolan, Stockholm, Sweden, May 10-11, 1954 (Published in Proceedings)

Development of Large, Intermittent Wind Tunnels

Journal of the Royal Aeronautical Society, London, pp. 259-278, April 1955 (Given Premium Award, Royal Aeronautical Society, April 1956)

Some Problems in Design and Operation of Blowdown Wind Tunnels

Zeitschrift fur angewandte Mathematik und Physik (ZAMP), Vol. 9b, Fasc. 5/6, March 1958, pp. 422-437, Fest schrift Jakob Ackeret, Birkhauser Verlag, Basel und Stuttgart

Experimental Investigation of Hypervelocity Flight

Advances in Aeronautical Sciences, Vol. 1, Pergamon Press, 1959, pp. 127-186

Development of Capacity- and Inductance-Driven Hotshot Tunnels

(Co-authors: W. G. Harris, R. Jackson, J. A. van der Bliek, R. M. Miller)
IAS National Symposium on Hypervelocity Techniques, Denver, October 21, 1960, Proceedings, p. 67

Effects of Boundary Layer and Geometry on Characteristics of Perforated Walls for Transonic Wind Tunnels

Aerospace Engineering, Vol. 20, No. 4, p. 22, April 1961

Aerodynamic Testing at Mach Numbers From 15 to 20

(Co-authors: J. D. Whitfield and R. Jackson)
Hypersonic Flow Research, Progress in Astronautics and Rocketry, Vol. 7, p. 473, Academic Press, 1962

Blast-Hypersonic Flow Analogy Theory and Application

ARS Journal, Vol. 32, No. 9, p. 1341-1346, Sept. 1962, see also AIAA Journal, Vol. 1, No. 3, p. 725, March 1963

Development of Hypervelocity Range Techniques at Arnold Engineering Development Center

(Co-authors: W. B. Stephenson, P. L. Clemens and D. E. Anderson)
ARPA-CARDE-ARGMA Symposium on Aeroballistic Ranges, Pt. 1, CARDE Tech Memo Q-646/61, October 1961

Some Studies in Supersonic and Hypersonic Aerodynamics at the von Kármán Gas Dynamics Facility, AEDC

Proceedings, Sixth U.S. Navy Symposium on Aeroballistics, BOWACA, National War College, Fort McNair, Washington, D.C., Oct. 31, 1963, published by David Taylor Model Basin

Status of Development of Hotshot Tunnels at the AEDC

(Co-authors: R. Jackson and J. D. Whitfield)
Chapter 17, p. 323 to 356, AGARDograph 68: "High Temperature Aspects of Hypersonic Flow," Proceedings of the AGARD NATO Specialists' Meeting, Belgium, April 3-6, 1962. Pergamon Press, 1963

On Homopolar Machines

International Science and Technology, Communications Center, pp. 15-23, June 1966

The Handicap Race of Science—Nobel Awards in Science and Medicine
American Scientist, p. 285A-286A, September 1966

Prepared Comments on the Calculation and Measurement of the Performance of Hypervelocity Launchers

(Co-authors: A. J. Cable, J. R. DeWitt)
Proceedings, Vol. II, Fifth Hypervelocity Techniques Symposium, University of Denver, March, 1967, pp. 55-67

Constant Acceleration Flows and Applications to High-Speed Guns

AIAA Journal, V. 5, No. 11, pp. 1955-1963, November 1967

Atmospheric Entry Test Facilities—Limitations of Current Techniques and Proposal for a New Facility Type

AIAA Preprint 69-166, 7th Aerospace Sciences Meeting, N.Y., Jan. 1969

Contributions by J. Lukasiewicz related to Studies of Research and Development activities and Impact of Technology.

Scientific R&D Activities of the Government of Canada: Diagnosis and Cure.

Private study completed in October, 1963 which received limited distribution to senior officers of NRC, NRB DOI and to some representatives of industry.

La Subvention de la Recherche et de la Mise au Point Industrielle, Review of Growth of Science and R&D with Particular Reference to Canada.

Colloque and Panel discussion, Laval University, Quebec, March 18, 1966.

Review of Growth of Science and R&D With Particular Reference to the United States.

ONERA, Paris, May 9, 1966.

The Handicap Race of Science: Nobel Awards in Science and Medicine.

American Scientist, p. 285A-286A, September 1966.

Growth of Science and Technology and Their Impact on Society.

AIAA Tennessee Section, October 13, 1966, OOM, Arnold Air Force Station, Tennessee.

AIAA Alabama Section, November 16, 1966, Redstone Arsenal Officers' Club, Huntsville, Alabama.

AIAA Greater New Orleans Section, November 27, 1967.

Growth of Science and Technology and Present Status in Various Countries.
Seminar, School of Architecture, University of Montreal, March 7, 1967.

Future of the R&D Effort and Predictions for the U.S.
Seminar, School of Architecture, University of Montreal, March 14, 1967.

Challenge of the Modern Society; a "Second Order" Education.
Public lecture, course on "Aspects of the Learning Process," Thomas More Institute, Montreal, April 10, 1967.

Research and Development Efforts and Engineering Education, with Particular Reference to Canada.
York University, Toronto 12, Ontario, Canada, Oct. 27, 1967.

Technology: From Problem Solving to Problem Making.
Invited lecture, 35th Annual Meeting, SE Section, American Society for Engineering Education, Miami Beach, 17 April 1969.

Mardon, James (Jasper): Personal Data—Nationality, Canadian; Born, April 10, 1921—Exeter, England; Parents, Harold Mardon, Dorothy Mardon, Née Humphries; Wife, Louise Dorothy, Née Simpson. Children, David Humphrey, Peter Edwin, Richard Jasper, Gunnar Harald, Andrew Sidney Dampier, Alexander Robert. Academic Training and Qualifications: 1929-1939, Heles School, Exeter, Devon; 1939-1946, His Majesty's Forces, Royal Artillery and Gurkha Rifles; 1946-1949, Selwyn College, Cambridge, Exhibitioner 1939, Scholar 1947, BA 1949, MA 1952; 1953, College of Science and Technology, Manchester; 1959, City and Guilds Insignia Award by Examination. Professional Engineer, Province of British Columbia; Chartered Engineer, Great Britain; Member, Institution of Chemical Engineers; Fellow, Royal Institute of Chemistry; Member, Institute of Fuel. Other Memberships: Companion Member, Institute of Mathematics, Various Pulp and Paper Technical Sections, International Association for Hydraulic Research, International Association of Scientific Papermakers, (President 1962-1966). Positions Held: 1949-1952, Technical Manager, Bridgend Tissue Mills; 1954-1960, Head, Paper Making Research Group, Anglo Paper Products, Quebec, P.Q.; 1960-1964, Assistant Director Research, Oxford Paper Company, Rumford, Maine, U.S.A.; 1965, Technical Advisor, Papermaking Major forest products company; 1966-Present, Technical Director, Pulp and Paper Group, Major forest products company. Medals and Awards: 1956, Weldon Gold Medal, Technical Section, Canadian Pulp and Paper Association; 1966, Weldon Gold Medal, Technical Section, Canadian Pulp and Paper Association; 1967, Elected Fellow, Technical Association Pulp and Paper Industry (U.S.A.); 1968, Prince Philip Medal, City and Guilds of London Institute; 1968, Beilby Memorial Gold Medal and Prize, Royal Institute of Chemistry, Institute of Metals, Society of Chemical Industry. Author of four books and one monograph on technical papermaking and one monograph on research and development (The Principles and Detailed Mechanics of Research Direction and Management); approximately seventy scientific papers (sixty on technical papermaking and ten on systems engineering) and about forty educational articles. Many of the articles have been translated into French, German and Russian and two of the books translated into French. One book has also been translated into Spanish. Principle Research Topics: Papermaking Hydrodynamics, Other Aspects of Technical

Papermaking, Including Drying, Calendering, Pressing, System Design and Stability. Other Positive Achievements: The designing of original training systems to bridge the gap between University and industry. A significant number of well-known engineers in the pulp and paper industry have received training directly under Mr. Mardon. Languages: Urdu, Swedish, French with reasonable facility, several other languages with minor capability.

Root, John Stewart: Personal Data: Nationality, Canadian; Born, 8 June 1921, New Westminster, B.C.; Wife, May, nee Jardine; Children, Pamela May, Loran Patricia. Positions Held: 1941-1946, Signals/Radar Officer, R.C.A.F. Service in U.K., India, Burma; 1947-1952, Merchandise Manager, Cossor Canada Ltd., Halifax, N.S. (Military and Commercial Electronic Instruments and Systems); 1950-1952, Commanding Officer R.C.A.F. Active Reserve Unit (Radar) Halifax; 1952-Present, President, R-O-R Associates Limited, Scarborough, Ontario. Electronics Engineers—Measurements, Data Systems and Communications. Technical Societies: Associate Member, Institute of Electronic and Electrical Engineers; Associate Member, American Physical Society; Member, Society for Experimental Mechanics; Corporate Member, Canadian Association of Physicists. Special Technical Competency Areas: Measurement techniques of electrical and mechanical parameters from DC through the microwave spectrum; Communications techniques. Other Activities: President, Canadian Electronic Instrument Instrument Representatives Association, Inc. (Trade Association); President, Telettra Limited (Telephone and Radio Systems); Director, Triad Instrument and Controls Limited (Electronic Weighing Systems); Donalda Club, Toronto. Languages: English; French, basic ability.

Timlin, Mabel F., Ph.D., LL.D., F.R.S.C.: Biographical Notes: Born Forest Junction, Wisconsin, December 1891; Emigrated to Canada, 1917; naturalized, 1930. Education: High School, Wisconsin Rapids, Wis., Completed, 1910; Milwaukee State Normal College, two years college credit plus teaching certificate, completed, 1912; B.A. (Great Distinction), University of Saskatchewan, 1929; Ph.D., University of Washington, 1940. University Appointments (University of Saskatchewan): 1. Secretary, later Director, in charge of administration of Correspondence Courses and reader in Economics, 1929-43; 2. Instructor in Economics, 1935-41; 3. Assistant Professor of Economics, 1941-46; 4. Associate Professor of Economics, 1946-50; 5. Professor of Economics, 1950-59; 6. Emritus Professor of Economics, 1959. Other Appointments: 1. Summer appointments: Department of Finance, Ottawa, 1943. Department of Mines and Resources, 1949. (The latter connected with preparation of a study on immigration for the Canadian Cabinet): 2. Consultant, Royal Commission on Prices, Government of Canada, 1950-51; 3. Consultant, Royal Commission on Saskatchewan River Development Project, 1952; 4. Member, Summer Research group and Seminar of Commonwealth Studies Center, Dake University, 1957; 5. Canada Council Special Senior Fellowship, 1959-60; 6. Research Assistant, Social Science Research Council of Canada, 1964-65. Other Activities: 1. Executive, Canadian Political Science Association, 1941-43, 1960-62; 2. Vice-President, Canadian Political Science Association, 1953-55; 3. President, Canadian Political Science Association, 1959-60; 4. Executive Committee, American Economic Association, January 1, 1958 to December 31, 1960; 5. Member, Committee on International Fellowship Awards, International Federation of University Women, 1947-56; 6. Member, Faculty of Canadian Seminar, International Student Services (now

World University Service), Pontigny, France, July-August, 1950; 7. Member, Round Tables on Migration, International Economic Association, Kitzbuhel, Austria, September, 1955; 8. Guggenheim Fellowship, 1945; 9. Fellow, Royal Society of Canada, 1951; 10. Centennial Medal, Office of Secretary of State, Government of Canada, January, 1968; 11. Doctor of Laws degree, *Honoris causa,* conferred by University of Saskatchewan, May 12, 1969.

PUBLICATIONS BY MABEL F. TIMLIN

BOOKS:

1. *Keynesian Economics,* Toronto, University of Toronto Press, 1942; Second Edition, 1948.
2. *Does Canada Need More People?* Oxford University Press under the sponsorship of the Canadian Institute of International Affairs.
3. Monograph: *The Social Sciences in Canada: Two Studies,* May 1968 co-author with Professor Albert Faucher, Publisher, Social Science Research Council of Canada.

ARTICLES:

1. "Price Flexibility and Employment", *Canadian Journal of Economics and Political Science,* Vol. 12, May, 1946, pp. 204-13, No. 2.
2. "The British Economy in the World Today", *International Journal* Vol. 1, 1946, pp. 324-36.
3. "General Equilibrium Analysis and Public Policy", *Canadian Journal of Economics and Political Science,* Vol. 12, 1946, pp. 483-95.
4. "General Equilibrium Analysis and Public Policy: A Rejoinder", *ibid,* Vol. 13, No. 2, May, 1947, pp. 285-87.
5. "John Maynard Keynes", *Ibid,* No. 3, August, 1947, pp. 363-65.
6. *Boom and Depression in Canada,* Saskatoon, Extension Department, University of Saskatchewan, 1947, pp. 11, Pamphlet.
7. "Theories of Welfare Economics", *Canadian Journal of Economics and Political Science, Vol.* XV, November 1949, pp. 551-59.
8. "Economics Theory and Immigration Policy", *Ibid,* Vol. XVI, 1950 pp. 375-82.
9. "The Harrod Life of John Maynard Keynes", *The Canadian Liberal,* Vol. 4, No. 3, Fall, 1951, pp. 161-66.
10. "Recent Developments in Canadian Monetary Policy", *American Economic Review: Papers and Proceedings of the Sixty-fifth Annual Meeting of the American Economic Association,* Vol. XLIII, No. 2, May, 1953, pp. 42-53.
11. "Monetary Policy and Keynesian Theory", published in the volume *Post-Keynesian Economics* edited by Professor Kenneth Kurihara, Rutgers University Press, 1954, pp. 59-88.
12. "Recent Changes in Government Attitudes Towards Migration", *Transactions of the Royal Society of Canada,* Vol. XLIX; Series 111, June, 1955, Section Two. Reprinted with added note in R.E.M.P. Bulletin (The Hague), Vol. 4, 1956, pp. 56-65.
13. "Canadian Immigration with Special Reference to the Post-War Period", International Economic Association, Round Table on International Migra-

tion, 1955. Published as Chapter 11 of a volume published by MacMillan, London, 1958 entitled *International Migration.*

14. *Workable Competition and Monopoly:* The Public Interest and *the Control of Combines* in Canada, with G. E. Britnell, *et al,* (Saskatoon University of Saskatchewan, 1956), pp. 16.
15. "Canada's Immigration Policy", Presidential Address, Annual Meeting of the Canadian Political Science Association, June 10, 1960; published in the *Canadian Journal of Economics and Political Science,* Vol. XXVI, November, 1960, pp. 517-32; reprinted in the *R.E.M.P. Bulletin* (The Hague), Vol. 8, 1960, pp. 77-91.
16. "The Law and the Bank of England", *Saskatchewan Bar Review,* Vol. 27, September 1962, pp. 66-87.
17. "Canadian Immigration Policy: an Analysis", *International Migration,* (Geneva), Vol. III, 1965, pp. 52-70.
18. In preparation Brief for the Special Committee on Science Policy of the Senate of Canada ,to be entitled "On the Support of the Social Sciences in Canada and on their Relation to the Bio-physical Sciences.

THE SENATE

SPECIAL COMMITTEE ON SCIENCE POLICY

EVIDENCE

Ottawa, Thursday, June 26, 1969.

The Special Committee on Science Policy met this day at 10 a.m.

Senator Maurice Lamontagne (*Chairman*) in the Chair.

The Chairman: Honourable senators, we have with us this morning six individuals appearing on their own behalf to present their personal views. This is unique in our proceedings, but I think that you may recall that we started that way more than a year ago, receiving wise men of science policy. It is good to recall this since we will terminate our public hearings tomorrow. It is a good exercise to return to dhe individual after this long travel through government agencies and national associations and companies, et cetera. We are very pleased, indeed, to welcome these people who have expressed great interest in science policy. Each of them, as usual, will make an opening statement. First of all, I should like to invite Dr. Timlin to begin, because of her long-standing interest in this field especially in the state of the social sciences in Canada.

Dr. Mabel F. Timlin, Emeritus Professor of Economics, University of Saskatchewan, Saskatoon: Mr. Chairman, I prepared a short introductory statement. I may add that I was advised to get it printed because the press might otherwise not understand everything in my brief. Of course, I did not believe that, but I took the advice. The brief as presented to you is a supplement to the report which was published last May on social sciences in Canada. Slightly over half of the brief itself is devoted to problems of multidisciplinary research, particularly those involving the biological and social sciences.

I am amplifying what I say in this just to state that I have a profound belief that a great deal of the future in research related to social policy is going to be in the area of multidisciplinary ventures. Partly it is due to direction of science and to the startling convergence of the biological and the social sciences at the present time. For that reason I introduced in the brief quite a lot of material on the international biological problem.

What I tried to do in the first section of my brief was to work out the conditions that can make for a successful multidisciplinary project. Four of them are mentioned in my brief. At the suggestion of Dr. Safarian I would like to add a fifth one which is that before you plan a multidisciplinary project an agreement should be made with respect to publication rights, otherwise you will have trouble with the university professors. Since returning home from the meetings I found that the project with which I deal in the brief has made very careful agreements with the purchaser about publication rights. To get the professors to work together they have to be able to get their separate credits on the enterprise.

The second portion of my brief deals with Social Science Research Council of Canada generally, its relation to the Government, and certain of its needs.

The third portion deals with the general problem of the structure of a government financing agency likely to be most effective, not only for the support of research in Canada but also for furtherance of multidisciplinary research projects, requiring co-operation between the social sciences and the natural sciences.

I have read several thousand pages of the proceedings of this committee, and I have been very much impressed by them. However I was a little disturbed at the earlier hearings, because GNP almost seemed to be an end instead of a means seen in a human perspective. You will notice that in my brief I deal with two areas in which I think one needs to see science policy in a somewhat wider framework. Firstly there is the fact that you can have odd and adverse results from too great an emphasis on GNP, because there are circumstances in which you can sustain the

short term growth of the GNP only at the expense of the future. You can overcrop, overfish and underfeed your land, and many other things, which can increase the product perhaps in terms of cost-benefit analyses without damaging the present, but with damage to the future.

In the second place, it seems to me in a great many of the presentations, there is a tendecy to overlook the importance of measures leading to the development of the human input. I would just like to read a paragraph that I wrote about. This "It seems to me that in the present world of monetary disorders, in a worldwide inflationary bias, transfers of funds through the tax system are likely to be very imperfect and temporary instruments for the solution of social problems. It seems to me that they can provide a temporary shelter for the least advantaged groups in a society where both basic and applied research seek out avenues for the development of the human potential."

You may think this is special pleading, but I have good reason for saying this, because for the aged the universal old aged pension must be justified not only for the indigent but for others on the grounds of the general destruction of purchasing power, savings, pensions, insurance and other monetary assets accumulated during the past 30 years of pensioners' working lives.

In general I think the aim of welfare should be the establishment of conditions that can in time eliminate the necessity for welfare programs for all except those whom chance or congenital mischance has made incapable. A postman who loses his legs in a railway accident is entitled to protection; for a child born mongoloid there should be welfare. I really believe that the avenues of both basic and applied research should be developed with some concern for the human input so that men and women may be made into as competent human beings as it is possible to make them, not only for society's sake but for their own.

The brief suggests one avenue of both basic and applied research that could uncover the nature of possible institutional changes conductive to improvement of the human input, and therefore also the long term rate of growth of the GNP and the quality of life.

In the June, 1969, issue of *Science Forum* there is a statement by a biochemist, the newly elected president of the United States Academy of Sciences:

"The human gene pool is colossal in its potential variety."

It seems to me the most important areas of research where both the biological and the social sciences concern environmental conditions which can enable that potential variety to come to its completed fulfilment.

I hope that was not too long, Mr. Chairman.

The Chairman: It certainly was not. On behalf of all members of the committee I certainly want to thank you, Miss Timlin, especially perhaps for these post-Keynesian notes that we have received from you this morning.

Senator Grosart: Post-Benson notes too.

The Chairman: We will now hear from Dr. English.

Dr. H. Edward English, Director, School of International Affairs, Carleton University: I will be very brief in introducing what is rather a long submission, I am afraid.

First I would like to say how pleased I am to have been invited here this morning, and how honoured I am to follow such a distinguished colleague as Professor Timlin, who has made some of the few Canadian contributions to the theoretical literature of economics. I appear here much more as an applied economist, and probably even more so in this context as someone who has an interest and a little experience in the organization and direction of economic research.

I should perhaps say, because it is relevant to a part of the brief, that I spent a period of four years with the Private Planning Association on leave from Carleton University. I am not hiding that fact in making references to, and even proposals regarding, the development of that association's work. I should perhaps add that I am now an economic adviser to the association. I do not apologize for having the relationship between that fact and what is referred to in the latter part of the brief. I think the case can be made out on grounds other than that association.

My main points this morning really relate to the points made in the summary, first that as an Ottawa observer over the past twenty years I have felt that while there is a very great quality in much of the economic and social research that has gone on under government auspices in this time, there has been an uneven performance, to say the least, and

that there is great scope for what I would call rationalization government's own economic and social research services. There has been a lot of ingenuity shown by the methods by which research is sponsored by the federal Government; the old traditional devices such as royal commissions have been widely used, and more recently there have been task forces and of course I should mention the Economic Council which is a continuing agency of very great importance. Then there have been the departmental research facilities. With all this it is significant that there is still a feeling of uneasiness and some dissatisfaction with the average level of performance in the area, and the suggestions I make in the first part of the brief have a bearing on that. It seems to me there is scope for a better working relationship between the academic economists and government economists, and one of the suggestions I make concerning research co-ordinators has in mind the possibility of achieving that better flow of information and support and advice from the academic community.

I also have some comments to make on the way in which pure academic research is supported. I feel that the nature of applied social research is such that there is great danger that the independent sector, the sector which is not in any way contractual or tied in with specific problems of government, will be deprived through the market process, and one of the answers to this may be the necessity, I think, for a stipend basis used more widely to ensure that independent research is supported.

The final and one of the most important points I wish to make is that we in Canada have put a great deal of stress upon public research and publicly supported research. We have as a consequence, I think, a less developed private sector in economic research than most of the other western countries. Most of the countries whether they are large like the United States with their many private research institution or whether they are small like the Netherlands or Sweden publicly support the privately operated research institutions, and institutions in the private sector, the non-governmental sector, which provide important competition for governmental research activity, but in a much more important sense provide a complimentary service.

I think in Canada when we have tried new experiments, we have tried, even right up to very recent times, to look to new governmental institutions where there is opportunity, I believe, to support the expansion of this kind of work in the private sector, and I mentioned some specifics in this connection. That is all I wanted to say.

The Chairman: Thank you very much, Dr. English. Now Dr. Lukasiewicz.

Dr. Julius Lukasiewicz, Professor and Associate Dean for Research, Virginia Polytechnic Institute: I would like first of all to thank you for inviting me here; indeed, I am delighted to participate in this discussion. It may not be clear why a man living in Virginia has something to say about the matters of interest to this Committee. Therefore, let me say that my association with the research in Canada dates back to the period between 1948 and 1958, and that all of my professional life has been in aeronautical and aerospace research, in the United Kingdom before 1948 and in the United States after 1958. My continuing interest in the Canadian research scene is the result of my experience with the National Research Council (N.A.E.). While there, I have been largely responsible for some $10 million of your tax money being eventually spent on the construction of a high speed wind tunnel at Uplands, a tunnel which, I am afraid, has not been very useful to the country, although technically it was and still is a sound, high performance facility. The only trouble was that, even before it was completed, the need for it had already vanished.

Since leaving for the U.S. in 1958, I have been staying in fairly close touch with what goes on in the area of science, research, and development in Canada. To summarize briefly what I wanted to bring up today, I would like to make first of all some general observations about science and technology. From my own perspective it seems clear that science and technology are, by their very nature, devoid of a national character. In fact these activities, in spite of politics and any other pressure factors, largely do not respect the political boundaries. This is seldom recognized, even by such advocates of international technology as Servan-Schreiber, the author of "Le Défi Américain." Although Servan-Schreiber would like to see the abolition of the traditional European nationalism, he would nevertheless like to see a large-scale "continental" nationalism built-up in Europe, in opposition to the U.S. Paradoxically, while recognizing the failure of technological nationalism within

Europe, Servan-Schreiber advocates it on a continental scale. It does not work on a national basis in Europe and it would not work on a continental basis, either. While Servan-Schreiber's arguments are quite sound, he does not appear to be able to apply the consequences beyond a continent.

Compared to Europe, I believe that in Canada we have a sort of opposite situation, with Canada being very closely related to the United States. In fact there are no two countries more closely involved. Yet for political (national and prestige) reasons there have been attempts—and the $10 million spent in Uplands is an example of this—to somehow build up a national aspect of high technology in Canada. There is no reason why such attempts—based on political considerations—should succeed. I think that, although sometimes politically unpalatable, it is nevertheless true that technology, because of its very nature, tends to erase national characteristics: the characteristics of a television set belong to the set and not to whichever country produced or invented it.

With this introduction from the point of view of one who is looking at the Canadian scene from outside, one can go on to look at the R & D effort in Canada. The usual argument is that not enough is being done because the United States spends three per cent of its gross national product on R & D and Canada spends much less, about one per cent. However, I look at this question somewhat differently. If you consider the R & D expenditures per capita in Canada and the gross national product per capita in Canada (i.e. the standard of living, then you will find that Canada is in an extremely desirable position because it is on the line of minimum R & D expenditures for a maximum standard of living, and moreover, its standard of living is very high. That, of course, is a situation that every nation would like to be in. Clearly, most of the R & D from which Canadian consumer benefits, is paid for by the big U.S. market, more than ten times larger than the national market, and the technical developments are available to the Canadians at a very low cost. If one were concerned only with economics, this would appear to be a very desirable situation. In fact, the less one spends on R & D to achieve this high standard of living the better off one is. That is one point perhaps worth recognizing.

Incidentally, comparing Japan to Canada, it is apparent that Japan was in a completely different situation. Unlike Canada, it had to make great efforts to import technology, and it did so very successfully; it did not seem to mind that technology was imported. A story related by Senator Grosart and printed in the proceedings of this Committee is a measure of Japan's success. When asked what was the major problem in Japan's export markets, the head of the Japanese trade mission replied, "Cheap American imitations."

The second aspect that has been discussed in Canada very widely is the structure of R & D funding. I think there is a general agreement that it is much too much oriented toward basic research and not enough toward industrial development. I do not think this needs belabouring.

I should like to make one observation concerning NRC, the organization in which I worked and which I know fairly well. It seems ot me that nothing would be lost and everything gained if NRC were transformed into a graduate school of science and technology. At present, the laboratories, extremely well equipped, serve mostly to educate the civil servants who work there, that is a very small number of people in relation to the facilities available. Under the proposed scheme, advanced graduate education would be extended to a large number of students served by excellent physical plant. The new graduate school could be associated with a number of universities. Initially, the members of the NRC staff who would not qualify for joining the faculty could work on projects funded by the government on the basis of specific contracts, which is a flexible and convenient funding technique. In general, services required by the government would be assured on a contractual and competitive basis. As regards NRC's large scale, industrial-type laboratories, or activities related to technical and scientific standards and patents, these could be administered separately, the former preferably under contracts for operation by private firms. Under the proposed organization such developments as the wind tunnel to which I referred earlier would be less likely to take place.

Finally, as regards short-range aspects, let us consider what sort of R & D should be done in Canada. I feel that one of the areas of importance is the productivity. While this may not be related to any specific product or any specific sector of economy, in general the productivity in Canada, as is widely recognized, is

quite a bit lower than in the United States. Whereas the technology s essentially the same, the productivity is much smaller. Of course, this situation affects the standard of living very directly.

I would like to say a word on military R & D. I think there is no reason at all to be concerned in Canada with the development of any original military equipment, because in any large scale operation logistics would dictate the use of common equipment. Instead, one should perhaps be concerned with operational research. In other words, with how to use effectively, in the field, modern equipment. This is something that could add interest to the military life in peacetime, and presumably would have some merit when forces are deployed.

Finally, I think there is a large area of what I would call non-utilitarian and selective consumer goods which are well designed, such as textiles, furniture, etc. Here the proximity of 200 million people to the south of Canada is a pure benefit. While not a world market, it is a big market and could be exploited. Of course, there are countries such as Denmark and Sweden that do extremely well in this area.

I should like to come now to the aspect that I think is really more interesting and this is the long-range aspect. We said that not much is being spent on R & D in Canada and that perhaps, in view of the availability of the American technology, this was all right. However, there is perhaps one area in which bigger expenditures would be very well justified. What I would like to discuss here for a minute or two is some of the undesirable characteristics of the highly technological society. These are becoming more and more evident in the United States. People literally do not know how to tackle them or what to do about them. There is a long list of problems, but there is not sufficient time to discuss them here. Let me just mention one or two interesting situations in the United States.

The consumption of milk in the United States is regulated to the extent that if cow's milk contains more than 0.05 parts per million DDT it cannot be marketed. In the U.S., human milk now contains 0.1 parts per million of DDT and, of course, its production and consumption are not controlled. Should it be "marketed"?

The space program provides us with another extreme example of pollution. It is really fantastic that one trip to the moon produces six million pounds of garbage. None of the equipment is used again, including the capsule that returns to earth. Six million pounds expended for a payload of three people for a few days. Six million pounds of gas would last a car some 15 million miles. There is a lot of garbage in space already. There are about 400 objects flying around in earth's orbit, and they have collided in the past.

The problems of detrimental effects of technology are extremely serious and very little is done about them, because they are essentially very complex. Man's intellectual ability is almost completely inadequate to cope with them, and it is not obvious how to overcome this basic deficiency.

As regards the questions of undesirable effects of technology, the situation in Canada is particularly interesting, the technology being the same as in the U.S., but the political control being independent. This, I feel, could be exploited to a very great benefit to Canada. Canada has a huge socio-technological laboratory down south which is always the first to make experiments and produce results—some five to ten years earlier than they would appear in Canada. If one were perceptive, one would take advantage of this situation to a very large extent. This is where one perhaps should spend the other two per cent of the GNP, since otherwise these undesirable phenomena will occur. Technology has an awful lot of negative effects. I would perhaps sum this up by saying that the man-made, artificial environment is usually unstable. Man has not developed a stable environment. The natural environment is stable in terms of at least the time span of the human life. It evolves slowly and stably. Artificial environment is an open-ended system. You buy more cars and consume more gas and you build more highways with the gas tax revenue to facilitate the use of more cars... In Toronto, they are building numerous freeways around the airport. This will not solve the traffic problem; a link to the subway system might.

Perhaps another comment is that in the whole transportation field, one should really try to eliminate the need for transportation. If everybody feels they have to travel from Montreal to Vancouver, obviously no transportation system would be adequate. On the other hand, with audio-visual electronic

means there can be more consultation and discussion without physical proximity.

I suggest that there is a great opportunity to do such things; the laboratory is there the experiment is run at a terrific cost, but not to Canada. Advantage should be taken of it.

I should have mentioned earlier the well-known question of how to manage R & D in industry in Canada, how to avoid the satellite branch companies, which one feels are not significantly performing in innovation. What I have to say has been already advocated by some people before this Committee. Perhaps the only way to tackle this problem is to realize that in modern technology we must deal with a large market, and that, therefore, Canadian industry must specialize in order to secure such large markets. The opportunities for economically significant and viable R & D in Canada lie in specialization within industrial operations of large firms, Canadian or foreign controlled; without such specialization, essentially only the domestic market can support innovation. This is another international aspect of high technology. On the basis of specialization within large international operations, top-notch talent can be maintained and larger operation assured. It seems that again nothing is lost but everything is gained, with competent people active in high technology. To make a replica of a comprehensive technology within a society of relatively few people is not viable, because market size will control the development of technology.

The Chairman: Thank you very much for your remarks, and for having accepted the invitation to re-visit the site of your crime! Thank you also for perhaps a new national motto: Let us study the American problem today in order to understand the Canadian problem of tomorrow.

Senator Grosart: Or the other way around.

The Chairman: We will now hear from Professor Burke.

Professor F. Eric Burke (Department of Management Sciences, University of Waterloo): Mr. Chairman, honourable senators, I should like to make a few points, perhaps three, in amplification of or addition to the brief already in front of you.

First I should like to clarify its scope a little more successfully than apparently I have done. Coming at the end of many thousands of pages of evidence you have heard, I did not attempt, and I do not want to be read to have attempted, to cover the whole range of science policy and all that you in your deliberations have found and in your final report say should be done about Canadian science policy. On the contrary, I was attempting to be exceptionally careful to make a very specific and restricted contribution arising from a very specific and restricted and very biased viewpoint, which I believe has been relatively ill-represented amongst the witnesses who have appeared in front of you in general, although I find that they have been exceptionally well represented by comparison to the average today in my distinguished predecessors this morning.

I am concerned, as an ex-engineer, an ex-research person and an ex-director of research with problems of how results can be extracted from the innovative processes that go on in western society and on which the success of western society has largely been based. These studies have led me to pay particular attention to the limitations of human capacities, to the differences between innovative processes, of which a great variety exists, which we do not understand at all well. Out of this great variety, for the purpose of this brief I have selected one class that I believe has been relatively neglected, though again my three predecessors, each in their own ways, have emphasized aspects of it, and that is long term work of a type which presently does not exist to any significant extent in Canada.

My scope, then, is partial and hence incomplete, in that it has not drawn complete inferences from the structure of the apparatus of science policy that may result from your total deliberations. On the other hand, I believe I have written into the brief—and you may wish to extract from me a discussion out of this brief—some inferences about what will not work in structures for science policy. That is the scope.

As the second part of these introductory remarks, and for the purpose of avoiding what I think occurs in many of these discussions of very complex matters, I should like to define, explore, and if you like propound—although it sounds pompous—concepts that I have taken for granted in writing this brief, although perhaps I was rash in taking these for granted. The first of these concepts is very common among electronic engineers and cer-

tain information specialists, and is that information and uncertainty are mathematically largely equivalent, that information conceived of as information scientists do these days is that amount of data required to reduce uncertainty to the point of uncertainty. This is particularly important to the points that will recur as I go through this discussion, that human information capacities are distinctly limited, and consequently that certain organizations will not be able to cope with uncertainties of a greater order than some quite readily specifiable limits.

The second concept that I am presuming in this brief is that amongst the types of economic factors resulting from innovative events in society are two significantly different classes, one of them being labour releasing and the other being labour absorption. These are, as I said, innovative events extending over periods of time. To illustrate this I will talk about the automobile industry, for no better reason than that its pattern is particularly clear.

Clearly, before 1900 virtually nobody, in terms of per cent of the labour force anywhere, was employed on making automobiles. It is not quite as well known that the maximum percentage employed on making automobiles in the United States was so employed in 1929, and that since then the percentage of the population employed making automobiles in the United States has steadily decreased, although the population of this continent has bought per capita more and better cars quite steadily. Since then, whilst the physical output of automobiles has vastly increased, the labour requirement has vastly decreased, because obviously productivity has increased far faster than physical output. So there has been, using the concept I am trying to define for you, a transition from labour absorption first on the new service introduced into society to labour release from this same bounded system providing a given kind of product or service. And it appears to me that it is important to recognize that labour absorbing innovative events have been only accidentally in balance with labour releasing innovative events over the last 200 or 250 years and it is because of this balance that it can also quite readily be disturbed. I believe, although I cannot prove it to my own satisfaction yet, that this balance is in a condition of being very substantially disturbed in the United States now and will be very substantially disturbed in Canada in the very near future.

The third concept I would like to introduce really is a connection between the first two. I believe that there is high uncertainty innovative behaviour and low uncertainty innovative behaviours. You will note from my first concept that this means that there is an innovative behaviour that uses an enormously large amount of information and there is an innovative behaviour that uses relatively small amounts of information. I believe there is a strong correlation between labour releasing innovative events and labour absorbing innovative events. You can increase your productivity of something that exists with far less uncertainty because it is there for you to see. It is much easier to improve on something that exists or on processes which already turn out something than to think up something that does not exist or processes that do not yet operate. So, as I say, there exists strong correlation between high uncertainty innovative behaviour and labour absorbing innovative events to which I would suggest we need to pay more attention. If these are not in balance the result is first underemployment and if underemployment persists it means a misuse of human potential and eventually social collapse.

The fourth concept I would like to talk about very briefly is the matter of high research content technological importation and here I am very much obliged to my predecessors this morning for having established an atmosphere of agreement with what I am about to say, although I had thought when I came here it was unconventional. I would suggest that the evidence in favour of a high research content and technological innovation is much stronger than has yet been presented to you. It arises from research patterns in Japan in the last 20 to 40 years. You have had this referred to already by Dr. Saburo Okita who appeared before you on November 27, 1968 when he spoke to you about how this situation was dealt with in Japan. It has also been my privilege to listen to Dr. Oshima in Cambridge in April of this year who gave vastly more detail than was available to you in November. The major portion of my brief deals with the implications of the pattern of technological importation practiced by Japan—not preached by them, but practiced by them. An enormous concentration of basic or fundamental research is devoted to the question whether in any given instance technology ought to be imported or not imported. What Japan is doing has been converted in the brief into equivalents for the

United States and if you wish the actual numbers I can look them up for you later; I cannot remember them off hand. They use perhaps two or three times as many fundamental scientists for economic output as the United States does in its civilian economy to import effectively and when in wisdom not to import at all. This is the present pattern in Japan.

I would offer it to you as a definition of the concept of the importation of technology with a high content of research personnel. That is the last of the four concepts I want to define.

I would like at this point to formulate very briefly the two recommendations with which may brief has concluded. One is that in addition to many things which have been said far better and more conpetently by witnesses and in the thousands of pages of briefs submitted to your committee concerning mission-oriented research and the administration of vast but relatively short-term research programs there exists a shortage in Canada, which is in my view crucial in the long run, of sustained, individual and aggressive innovative behaviour of a very long-term kind, and need for an atmosphere of government incentives to support them. Such support has not, in many historical places, been effectively provided within administrative hierarchies based on optimization. One example is the administration of the United States Defence research program, as disclosed in the "Hindsight" study which disclosed that innovation there has often occurred in spite of the "system". Another historical example of the weakness of hierarchically organized support is the relative demise of the German science since the turn of the century, as demonstrated by Ben David in the OECD publication *Fundamental Research and the Universities*. In spite of this regress in science, but on a basis not available in Canada, Germany has grown. Thus I recommend to you that there is need to have means that are not administratively oriented for the fostering of individual, sustained aggressive innovative behaviour in Canada, such as incentives, etc.

The second recommendation is that there is need for a plurality oriented rather than a single recommendation oriented body in Canada which can evaluate those areas in which it is particularly useful for Canada to give such incentives to individual, sustained aggressive innovative behaviour. Those are the items that my brief focuses on, and I would be very happy to be questioned on these matters. Thank you for listening.

The Chairman: Thank you very much, Professor Burke.

Next we have a joint submission by Mr. Mardon and Mr. Root.

Would you prefer to speak in English or in French, Mr. Mardon?

Mr. J. Mardon: I can speak in either English or French, depending on which you prefer.

The Chairman: Well, it might be better if you spoke in English.

Mr. Mardon: Mr. Chairman, honourable senators, it is with a curious mixture of humility and self-assurance that my colleague John Root and I find ourselves in front of you today. The reasons for humility need no enlargement; those for self-assurance deserve explanation since they are those that justify our taking up your time.

We submit to you that a science policy for Canada cannot be merely a synthesis of the various points of view of those who are expressing honest opinions of self-interest whether consciously or unconsciously.

In ancient times civilizations fell when mankind lost control of its environment. We can call the roll of long silent cities and long dead languages, Ur of the Sumerians, Nineveh of the Assyrians, Babylon, Susa and Perseopolis of the Achaemenian Persain Empire and Carthage of Hannibal. In this long list rolling down the millenia, only Athens and Rome are still with us.

The evidence of the loss of control of the environment is still to be seen, the deserts of the middle east, once the fertile valleys of Babir, called the Farghara, over which great poems were written, the deserts of Iran, the great North African desert that once provided the grain to feed ancient Rome with a population of a million and a quarter.

In all these cases the loss of control environment was due to the effect of war. It is sobering to realize that the degenerate state of southern Italy is a direct consequence of the Hannibalic war of the late third century B.C., which desolated the area, until then one of the most fertile in the world.

Today, as was recognized by Admiral Rickover, in his speech "A Humanistic Technology" we are faced with a new danger—loss of control of environment through the failure to control technology.

Rightly in our opinion Admiral Rickover distinguishes between a policy for science and one for technology. As Donald Hannig in his speech "Scientists and Politicians" points out science—by which he means science and technology—cannot now be separated from politics.

In formulating a science policy for Canada, therefore, we believe that we should strive to minimize the adverse effects as well as harness those that are beneficial.

We must distinguish between technological achievement and social gain. The Egyptians built the pyramids but ruined the empire which lived on in a comatose state for nearly two millenia; the Romans built the Circus Maximus with 380,000 seats but the civilization of which they were guardian was overrun.

In the brief which we submitted—and for whose inefficiencies we apologize—we have set out definite conclusions and recommendations; and Mr. Root will summarize those for you.

Mr. J. S. Root (President, R-O-R Associates Limited, Toronto): Mr. Chairman and honourable senators and Dr. Timlin. Our perspective, because of our day to day activities, is of the physical sciences, the scientific side as seen from the point of view of industrial activities primarily.

The purpose in summarizing the recommendations and conclusions of our brief is to refresh your memory regarding the points we have made, to facilitate questioning. Our brief contains, we think, some unusual and provocative suggestions, which nevertheless we believe in. Defence of this point and explanation of others in reply to your questions, we see as our contribution today.

In summary, we have said that we believe that industrial research and development in Canada is not as effective as it might be and we suggest action to raise this standard.

We consider the level of scientific education inadequate on our high school student level as they pass to university. It is pointed out that the state should take an active and creative part in battling technical obsolescence, what might be described as a national leave of absence policy for deserving cases, is suggested.

We feel that the gap between industry and university must be bridged from both ends. The comments by Dr. Lukasiewicz seemed to support some of these concepts. We also point out that woman power is not used effectively in science and technology.

Examining our recommendation more closely, we especially draw your attention to the means we suggest to break what we describe as the Ph.D. school. We direct your attention to the idea of establishing a national engineering academy, and also to our comments regarding systems engineering. This last is a most important interdisciplinary activity, and Mr. Mardon is a world authority on it and is looking forward to questions on this point.

Finally, quoting Mr. Mardon's dictum, it is not what we do not know that holds us back: it is what we do not use. We therefore feel particularly strongly that the idea deserves your attention, is of a prestigious lecture series to spread current technology at the level where it will be used.

That is a very short summary of the major points in our brief.

The Chairman: Thank you very much.

Senator Cameron: Taking the last point, the suggestion of a national engineering academy just referred to. This I presume relates to the suggestion made several times, that we should establish centres of excellence in Canada.

Mr. Mardon: Not quite, senator. We feel that at the moment Canada is in danger of being swamped by the third state, where universities are assuming the position of privilege occupied in older times by the Church. Engineering advice, we believe, is necessary if the body is to be balanced and our idea was an assembly of the country's eminent engineers, a senate of engineering, if you wish, which could be put together so that in debate on engineering matters this group of eminent engineers could provide counsel to the Government of the day.

The Chairman: Your expression is not too happy, because senates are not very popular in these days.

Mr. Mardon: If I may say so, with due respect, Mr. Chairman, at any rate our respect for the Senate has been materially improved by reading the proceedings over the past year.

Senator Cameron: You also referred to the development of a systems approach. This also was raised before. Would you elaborate on it?

Mr. Mardon: Systems engineering is ill understood in our country. I work for one of the country's great companies and, in order to find a suitable course for one of our engineers of promise, we had to send him to England. Today we would send him to the University of Purdue in Lafayette. But a few years ago, when we made our decision, there was no such course in the United States.

One can look at systems engineering on the basis of pull and push technology. When some invention occurs, it pushes the development of the technology to a certain point. After that some kind of system will be evolved which demands that further inventions be made and from that point onwards one should look at the particular human activity involved from a total point of view, and this total planning and total viewpoint is really systems engineering.

This would be more clearly understood, if I gave three examples. In the case of the railway, once the density of traffic on the lines became such that it could not be handled, the railways moved, a hundred years ago, into systems engineering and they had to have block signalling. It is of great interest that Brunel, the railway engineer, realized that systems engineering existed and designed his last railway, the Great Western Railroad, on a total systems plan. So, too, in telephone communications, once the density of calls became sufficient, automatic switching was forced. It had to be invented. In the case of the airplane, once the density of air traffic became sufficient, one had to have air traffic control.

All these things are concerned with moving information around and controlling that movement of information. And the systems engineering to which we are referring concerns the process of control.

Most industrial processes have moved into an era where control of the process is only possible when one looks at it from a total point of view—that is the systems engineering point of view. But schools of systems engineering were the last of the great engineering schools to be set up. The two best schools in the world today are at Purdue and at the University of Lancaster in England.

There is a reason for these schools being so slow to get started in North America. Most North American professors are pre-eminently preoccupied with raising funds for their departments.

Senator Haig: You are speaking to one who knows that situation very well. Senator Cameron is the principal of the school in Banff.

Mr. Mardon: Yes, I realize that, and I look forward to an invitation in due course.

Because of this fund raising, there is a strong interdepartmental rivalry. But systems engineering is an interdisciplinary approach. Therefore, you have to have co-ordination of different departments.

It is significant that systems engineering schools which were really effective first arose in new universities where this interdepartmental rivalry did not exist.

If this total process control and the expansion of our plants and industry are to be made efficient, systems engineering must be developed, for it is one of the keys to the improvement of industrial efficiency in any large industrialized country, and in Canada there are very few large companies which have their own in-house systems engineering groups or departments.

Professor Burke: I was just going to say that there are two in Canada, and the representatives of one of them sit right here.

Senator Cameron: Mr. Chairman, Dr. Lukasiewicz made the statement, if I understood him correctly, that there is no reason why more money should be spent on research and development in Canada. That is a direct contradiction of most of the advice we have received.

Dr. Lukasiewicz: If I may clarify, I did not really mean to say that, and I think I have indicated in what areas the spending of the R & D money in Canada should be augmented. I did say that because of the actual situation which allows the Canadian consumer to benefit freely from the R & D performed in the U.S., and because Canada has been freely importing modern technology, a task which has taken Japan many years of sustained effort—because of that situation there is no particular reason why Canadian expenditures on industrial research and development should be necessarily higher than they are. I think in the future there are problems, infinitely more complex and difficult, which in fact do necessitate large expenditures of research and development money, but in different areas, related to the undesirable consequences of high technology. This is really where Canada can exploit its situation, in my view, very effectively.

The Chairman: I think also you were suggesting that we should increase our research expenditures in the United States.

Dr. Lukasiewicz: I hope I did not imply that. In fact, I would like to advocate just the opposite. It would seem to me that the funding of research into the detrimental effects of high technology could get a tremendous amount of support from the United States funds because this is something that today is of even more vital importance to the U.S. than to Canada. In fact, it will be another 10 or 15 years before it is of the same importance here as it was to the U.S. yesterday. So I would say the opposite: this research could be substantially funded by United States funds.

Senator Cameron: Dr. Lukasiewicz said that some witnesses from industry have suggested that Canadian university graduates are not well trained in applying science and technology to the types of problems facing industry and suggested that Canada should really develop an applied technology institute such as MIT. He goes on to say on page 8 of his brief that:

> ...consideration should be given to transformation of NRC (and perhaps other government organizations) into a graduate engineering and scientific school to be affiliated with one or more universities.

Does the witness see setting up a national MIT in Ottawa?

Dr. Lukasiewicz: I did not consider in the brief the quality of training in sciences and engineering in Canada, but I did suggest the transformation of NRC into a graduate school. I suggested that because of the existing situation. I think it is generally agreed, that the existing, large and very well equipped government laboratories are not too effective in interacting with industry or contributing to the gross national product. Perhaps one could take advantage of these facilities by turning them into graduate schools of physical sciences or engineering.

Perhaps it would be interesting here to quote some numbers. Looking at the engineering education in the United States one finds that 50 per cent of the engineering degrees—and this is using the average figure for all engineering schools in the United States—50 per cent are in fact graduate degrees in engineering—master and Ph.D. or doctoral degrees. As regards the student enrolment, one finds that 25 per cent of the engineering students are graduate students. This says one thing clearly: it is obvious that sophistication in sciences is growing and that people have to study longer to cope with it and to innovate high technology.

So there is a sort of built-in opportunity, at least in terms of the physical plant and to some extent in terms of the very capable people who are in these laboratories—not all of them would qualify for faculty positions, but a great many of them would—to in fact advance the higher education. This would be infinitely more worthwhile than working on many small projects that really are largely irrelevant. You cannot bail out a company by doing research for it. Either a company is good—and, if it is good, it wants to do its own research because the important things you have to do for yourself, because you cannot afford to farm them out—or it is so marginal that it cannot cope, and, really, subsidizing such a company in that way cannot be very effective. Does this throw some light on your question?

The Chairman: I think Professor English would like to comment on that.

Dr. English: The only point I should make, really, is in the nature of a comment and a question. As I understand it, we should take a systems approach to education, I suppose, too, and, as I understand it, the present situation is that the graduate facilities training graduate students in engineering in Canada are already sufficient to meet the present market needs. I do not think they are necessarily doing the best job, but, in terms of numbers and available jobs for engineers, there are very much more extensive facilities in this field than in the social sciences, for example. It sounds like special pleading!

The question I really want to ask is, do you imply there should be a transfer of graduate training facilities, or in addition to all the facilities existing in universities. And, if so, what are the advantages of centralizing graduate training in engineering.

Dr. Lukasiewicz: I am not suggesting it is a systems approach, because part of the system is already there and it was not designed for that purpose. I have not done this, but I suppose that looking at the continuing funding of graduate laboratories in the physical sciences in Canada one would find that they are being continually expanded in many schools. So,

one cannot say there is a static situation. I am suggesting there is an extremely good physical plant which could be used to better purpose than it is being used now. If one had the choice, I am not sure where one would locate the laboratories, but since they already exist the question is how to make a more effective use of them. This is a serious question because, by and large, I think it is agreed that they are not too effective now.

Professor Burke: It seems to me that referring to the important factor of the increase of graduate schools in engineering and other areas, there are perhaps two special functions that could be fulfilled within the NRC laboratories which would be more difficult for university graduate departments to fulfil. One is post-doctoral work, not necessarily related to the earning of specific degrees; and the other is related to the sort of refurbishing experience many engineers and scientists need some 10 years after graduation, which is not particularly compatible with intermingling with students proceeding to further degrees immediately after doing undergraduate work.

Dr. Lukasiewicz: Continuing education.

Professor Burke: Yes. If you look at what NRC is now doing, one can view its contribution in this light and come to more optimistic conclusions about its value to Canada, if one so views it, particularly if one finds ways of financing the greater transfer of industrial people for sabattical periods into NRC, so that its facilities and its existing excellence are utilized in this manner. Would this be compatible with your suggestion?

Dr. Lukasiewicz: I do not think so because, in fact, these days the universities and some government "in-house" laboratories are often lagging behind the industry. Actually, so-called short-courses are extensively used as a means of updating. They are very well attended, are given by teams of specialists from industry and from universities.

I think that your suggestion could better apply to what I have been saying as to the future areas of research.

The present system in which we live, which is a consumer, free market system, does not in fact allow the development of any mechanism for the control of technology. There is nothing I can do as a consumer to buy a little clean air. I can buy a Rolls-Royce or anything else, but not individually clean air. It is again a serious paradox that socialism has failed to develop an affluent society, but that it might be needed by a capitalist, affluent society, to assure adequate control of technology. Here is a case where government certainly has to develop some mechanism for the control of technology. This is difficult since no such mechanism has existed before, and because technology of a different kind is needed. It is a technology which, instead of providing more consumer goods, such as airplanes and cars, would provide some more viable substitutes. Government laboratories could be used to initiate work on such lines. At present, I do not believe there is at NRC a single significant project which addresses these problems. So, perhaps that would be a good use for government facilities—but, I would advocate, always in the academic context, because I think this is an assurance of the highest quality and cheapest labour. This is worth while.

Senator Grosart: Mr. Chairman, I was asked to look at all these briefs and to ask some questions, and I know there are others who wish to ask questions too.

The Chairman: I must say that Senator Grosart has just returned from a meeting with physicists in Waterloo.

Senator Grosart: It was a hard day.

Dr. Timlin, on page 15 you refer to the family allowance question, which is beginning to be a great debate now. Could you tell us what degree of research is being done in Canada at the moment into the whole question of universality as a principle of welfare funding!

Dr. Timlin: I am afraid that having been ten years retired and totally immersed in trying to get a picture of all the social sciences outside my own, and having family allowances outside, all my information is just from my friends.

I do know that $6 in Saskatoon will buy a fairly good beefsteak dinner for one person, but probably will not reach the tip to cover it. I know that 25 years ago I was in on a very early discussion of this matter, in 1943, and that middle-income families many years ago were saving money industriously for the college education of their children, and if they saved it for 16 years now it would have nothing like the importance it had 25 years

ago. That is a very unsatisfactory answer, but I was just using it as a general example of a type of transfer through the tax system which had been eroded very significantly by changes, and I would think that even if you tied it very closely to the cost of living, you might come into some budgetary problems which might not be too well received by our present Government.

The Chairman: I note that I have just seen Professor Jantsch, the author of the famous book *Technological Forecasting in Perspective,* just enter the room, and I will ask him to come and sit here while we proceed with our discussion.

Senator Grosart: You suggest at page 24 that there has been an "invidious" discrimination against the social sciences in appointments to the Canada Council. Has that been reflected in a similar discrimination against the social sciences in the grants of the Canada Council?

Dr. Timlin: I do not think so. I would not put it in that way. I do not see why you need an academic panel if you have the kind of board that you have in the NRC. You could have special committees, as they have in the NRC. It may be a personal opinion, but I feel quite strongly about the fact that that type of board has to practically automatically confer most of the 3,000 grants. I think that each one of the committees of the NRC is able on a specialized basis to work in that fashion. Is that an answer?

Senator Grosart: Yes, very much so. Thank you. I was just interested in the word "invidious".

Dr. Timlin: Well, we felt very let down when we found out what the character of the first council was. It was so different from what we had expected. The first man who called me about it was Dr. W. P. Thompson, our president. He was almost in despair because he had expected a board very similar to the NRC.

Senator Grosart, I am concerned not so much in terms of the past, but in terms of what seem to be the problems of the future—the multi-disciplinary problems. Scientists do not always exhibit complete respect for the social sciences. Some of the criticisms are a little bit like accusing a Biafran orphan of not being a good weightlifter. That is because of the lack of the kind of nurture of the social sciences that we have in the physical sciences. With the kind of convergence which has arisen between the natural science fields and the social science fields it is more than ever necessary, it seems to me, that bodies dealing with other councils need to be bodies that are at the same level of expertise as the bodies they are dealing with. Do you know what I mean?

The Chairman: By implication, doctor, you would, it seems to me, be led to a separation between the social sciences and the arts?

Dr. Timlin: Yes.

The Chairman: So that you would have to organize a new council?

Dr. Timlin: I am making no argument as to whether you set up a separate council or whether you split the Canada Council. I recommended in my report a split in the Canada Council. The Macdonald study group underwrote my recommendation pretty strongly, but they recommended a termination of the mandate of the Canada Council for the social science...

Senator Grosart: In that one area.

Dr. Timlin: Yes. I am very well aware, as I put it in my brief, that there is a great deal of fear that you will get an interregnum in which the social sciences would be back where they were before. I do not know enough about the machinery of government to know whether a thing like the recommendation of the Macdonald group could be brought through quickly enough to calm those fears. Therefore, I take no position on this except the position that I would like a first-class board with the expertise which could meet the physicists and the biologists and all the other people on an equal basis. I know lots of people in public places, and I could name three and four who are not in the universities who could make awfully good public board members.

Senator Grosart: That, of course, Mr. Chairman, raises the larger question of appointments to these funding and guideline setting boards. I wonder whether any members of the panel can suggest a better way of nominating members than the one we have at the present time. I do not think everybody agrees that the NRC, the Atomic Energy Commission, or the Canada Council has the right people on it. Over and over again we have heard it commented that these are political choices. Is there any better way than

that of having the Prime Minister or the cabinet appoint these people. Does anybody know of a better way?

The Chairman: There is a variation of the traditional way with respect to the Economic Council, because appointments to the Economic Council, as you know, are made in consultation with the interested organizations.

Senator Grosart: Presumably they all are.

The Chairman: But this is an obligation contained in the act. It is the only case I know of where the minister, or the cabinet, is obliged by the legislation to consult with the interested organizations.

Senator Grosart: There are a good many other organizations that are interested in the work of the Economic Council and who object to the fact that they are not represented. However, I will not pursue that argument.

I would like to ask Dr. English about one very interesting recommendation in his brief. Surprisingly enough, I think this is the first time we have had it recommended that there be a research adviser and co-ordinator responsible directly to the Prime Minister. I think this is your main suggestion, Dr. English, and I compliment you on the way you have developed it. Do you see this particular person, who appears to have some relation in function to the President's Science Adviser, as an alternative to a minister of science policy.

Dr. English: The first point that I would make, of course, is that what I am proposing refers largely to the social sciences, and therefore, I think this would not be a substitute for a science portfolio, as I understand it. I have no position to take on that. I am not trying to suggest this as an alternative. I am no sure how I feel about the idea of the other portfolio.

I think I am putting forward this proposal in the context of the fact that we already have many departments of government doing social research. It is impossible to conceive of there being a department of economics in the Government, although in some governments there are departments of economic affairs.

Senator Grosart: There are in some provinces.

Dr. English: Yes, but I do not think they have been successful in achieving the objectives that I am setting forth for this appointment.

The basic point I would make is that research is a separate function from that of giving policy advice. It is like any argument for specialization. We have underplayed this particular specialty in the structure of government, and I think government has suffered for it. There has been inadequate attention given to the upgrading of quality in social science research going into the policy-making. To achieve that it is proposed there be somebody whose prime concern is the achievement of that objective, not in the context of individual departments—some of which have done well and others less well in their own policy research efforts—but in the context of government policy as a whole. There are many ways, as you know, in which the economic and social policy of government involves many departments, and decisions require not just the actions and advice of one minister but those of many ministers. I think it is a duplication; it is a lack of co-ordination. There are gaps which might be filled in by this kind of appointment. There is a lack of co-ordination and there are gaps, all of which might be remedied by this kind of appointment. I think the point of maximum emphasis should be that research requires, and particularly quality research, a kind of specialized knowledge capacity and preoccupation which makes it necessary for such a person not to be siphoned off into the existing work of advising governments on their own policy, but rather of supplying them with the formal base required for the economic policy advisers, and the Cabinet itself to make these decisions.

The Chairman: It would be some kind of a science adviser for the social sciences?

Dr. English: That is right.

The Chairman: As you know, there was, within the Government some years ago, a kind of interdepartmental committee on research in the social sciences, which was run from the Privy Council Office. We were told that this committee worked very well but that people at the official level refused to be co-ordinated, and the committee was abolished a few months ago.

Dr. English: One of the problems is probably that this committee had, as I understand it, no real connection with either the personnel or the kind of research standards involved in the universities. This is one of the big problems that government social science research has. It is very ad hoc in its orienta-

tion and it needs to be exposed. I suggest a rotating basis to be worked out for people coming in from the outside who become research advisers to the Government over a period of time. Of course, the other problem is that it needs to be clearly understood by the Government as to what the purpose is. One of the difficulties with the ad hoc kind of co-ordinating activities is that it has not really, in terms of reference, been as carefully defined as it might have been.

Senator Grosart: This is not necessarily a criticism but would it not mean a whole series of research advisers to the Prime Minister representing various sectors of the science community?

Dr. English: As I understand it, in the natural sciences there is a co-ordinator.

Senator Grosart: This is news to me.

Dr. English: Then I am not using the word "co-ordinators" in the right sense. There is a Science Council and a Science Secretariat. There are opportunities for making this system to serve these purposes. For the moment I should prefer to set aside the natural sciences.

The problems, as I amplify in the first part of my submission, are very different. There is sensitivity of course in the natural sciences and in policy designed to serve them, but the degree of sensitivity in social policy research and economic policy research is very much higher and much more on a day-to-day basis. As you know, it is an area of maximum sensitivity very often in a political setting. Therefore, there are many problems arising in this sector which tend to cover the problems of the quality of research itself and to divert government from a concern over the quality of research and information available to it. It seems to me that to recognize the necessity of the objective, high quality research and information, it is useful to have a person or persons to fulfill that role.

As I implied, I do not think it is necessary to take on very many people, that is on an experimental basis. I do think that if you talk about the whole area of social policy research then you would probably need certainly more than one principal figure, because sociology and applied social sciences related to sociology are certainly very different from economics and some of the specializations required in them. In sociology and economics you cover a large part of territory. It seems to me that a small staff working, particularly in those areas, could achieve much of the objective that I have in mind and one of the concerns which I think is implicit in your comments.

The Chairman: Do you see this man advising the Prime Minister or...

Dr. English: I was going to say this. I am aware that the Prime Minister has a problem of having many advisers and a very busy schedule.

Senator Grosart: Too many.

Dr. English: And I would say that the kind of position that is proposed here is not one which would involve very often disturbing the Prime Minister personally. In fact, I should think he is serving in that office, but his personal contact, if that is what you are concerned about, is not something that would need to be very frequent at all. The point is that he would supply to the Cabinet Committee or to the Prime Minister, through his efforts and coordination, a better flow of information and advice on where to get information relevant to social policy. He is not going to advise anybody on the policy itself. There is a risk whenever you appoint someone to do one job, because they end up doing another one. I willingly admit that, but I am hopeful that the terms of reference can sometimes be laid down specifically enough that this could be avoided.

Senator Grosart: I liked it better before you qualified it. I do not see kow you can have a man who is adviser to the Prime Minister and a co-ordinator of research without him being concerned almost entirely with policy.

The Chairman: That would be research policy as opposed to social policy.

Senator Grosart: They are going to be very difficult to separate in the future. I have another question arising out of your brief, page 13, paragraph 13. I am not clear as to your meaning:

> One is tempted to suggest that the office of the research adviser or co-ordinator be severely limited in staff size and that it be instructed to reduce the total economic research outlays of Government by a factor of several times its own budget.

It is a startling suggestion that there should be anybody representing the social sciences who even attempted to reduce the total economic outlay on research and development. I must be reading you incorrectly.

Dr. English: Not at all. I think the comment is made partly for the purpose of stimulating this kind of comment in question. The point, Senator Grosart, that I want to emphasize is that I feel there is scope for the rationalization of social policy and research in the Canadian federal Government. I am sure the same would be true in Government generally. The difficulty is that the need for research arises out of some urgent policy issue in the world of statesmen and it should have been anticipated, but in our real world it is never anticipated in that way. Somebody says, "Well, what will we do; will we set up a Royal commission and set up a task force and do it in a little group in government?" Various kinds of research are being used, but I think that an effective co-ordination and development of social research policy might have saved a lot of money over the last 15 years in this way, by not setting up royal commissions where task forces might have done, not setting up task forces where royal commissions might have done, and where occasionally a single project performed by a really outstanding specialist—I have given an example of that—might have covered much of the territory that an expensive commission covered.

Senator Grosart: You gave a very interesting example of that. However, I will not go into it. I have a final question, which relates again to the very interesting suggestion of the necessity for an independent research institute in Canada along the lines of the Brookings Institute and other institutes. On page 19 of your brief you say the key question is how the Government might assist in bringing this into effect. What do you see as the modus vivendi of the Government assisting in setting it up? I do not think this has been done in any other country.

Dr. English: Oh yes.

Senator Grosart: The government itself has set up an independent Institute?

Dr. English: Yes. In most of the smaller countries of Europe. It is done in a number of ways. I think the ideal way for independence, of course, is endowment, but that tends to involve too much initial expenditure for political acceptability, I suppose, to put it in a nutshell. For the kind of thing I have in mind you probably need in excess of $5 million to endow such an organization at the beginning.

Senator Grosart: We did something like that with the Canada Council.

Dr. English: Yes, that is right, in rather special circumstances. It seemed to work there, so it is not impossible. I think it would be highly desirable to contemplate that approach. I am not sure whether that approach was employed in any of the European countries. In most cases they seemed to operate on a sustaining basis, with a sustaining grant. Perhaps one of the best examples of that is the Swedish National Institute. Or it can be done on the basis of contracts, such as the national social and economic councils in London.

Senator Grosart: Contracts from whom?

Dr. English: From the government for certain kinds of research. The first time the government of the United Kingdom went into major contracts of that sort in support of the national institute, all the government members who had previously served as sort of board directors of the institute resigned in order to remove any possibility of misinterpretation of government support. This is also fairly common in the United States, with major contracts to private institutes. The contracts can be so worded and set up that the possibility of any untoward influence is minimized.

However, it is quite clear that the biggest problem is the continuity of those contracts. If at any time a contract is cut off the organization could be stranded. In the context of this submission, my view would be that one of the major activities for which there is a private as well as public demand—namely, current economic outlook activity—could be supported in the early years by commitment to a several years grant. That would provide the basis for development of an institute, which would by the end of that period be able to command a great deal more private support, as well of course as being better equipped to handle government contracts of the kind I have referred to.

Senator Grosart: Would you not agree that contracts or references by the Government to such councils tend to destroy their independence? I believe that both the Economic Council and the Science Council are out of their minds in accepting references from the Government, because by taking these references—such as the copyright, patent and trademark reference to the Economic Council—they are putting themselves in the position of becoming part of the public service; they are going to advise the Government on

what its policy is; they are going to do it without public hearings, so it will be in secret, and when the Government adopts—

The Chairman: It is not done in secret, but their recommendations are prepared, if you like, in secret.

Senator Grosart: That is what I mean and what I object to. I object to task forces for the same reason, particularly to the Economic Council turning itself into a task force to advise the Government what its policy should be on specifics, without consulting or having open hearings with the people concerned—industry, the patent industry and the copyright industry. This is exactly what is happening. It is happening also with the Science Council. I am suggesting that they are obviously destroying their independence by accepting these types of references.

My concept of both councils is as completely independent councils who can sit back and be completely free to tell the Government it is going in the wrong direction. In my view, they cannot do that effectively if they are part of the input of the directioning on which they are now required to comment. How would this apply to your institute if it is taking references and contracts from the Government? A reference from the Government is always a loaded question. I do not care how objectively it is written, it is a loaded question, because the Government says: "We have a policy problem. We are turning it over to you instead of to a royal commission or a Senate committee, but you know what we want."

The Chairman: I think you are going too far.

Senator Grosart: I am not going too far, because there are a lot of phone calls going back and forth to members of the Economic Council and Science Council...

The Chairman: You are too suspicious.

Senator Grosart: ...and sitting down to lunch with people who give them references. I am not going too far. I do not blame them. If I gave a reference to some group I would give them some idea of what I wanted back.

The Chairman: You are certainly too suspicious, because we are not doing this. You would probably do it!

Senator Cameron: It was a loaded question!

Professor Burke: I should like to comment on this.

Dr. English: I am competent to comment on only part of the question. Obviously I am not an expert in politics.

Senator Grosart: As a matter of fact, Professor English, you are.

Dr. English: I think the responsibility for appropriate political action on the recommendations and proposals of the Economic Council regarding this current reference on competition—which is something I happen to know a little about—lies on the Government. I do not think the Economic Council needs to share any of that responsibility. If the Government fails to have discussion, public or committee discussion, on the proposals it accepts, then I think there is a serious basis for criticism. Why should the Economic Council have to bear any of that responsibility? If the Economic Council has suffered from that particular reference, or from any similar reference, then I think the reasons lie in quite another direction, if I may say so.

There have been problems that the council has experienced in recent years, which I would say arise primarily out of the difficulty of relating sound research to the other function of the council as a social policy advisor. I do not think any of those who wrote about the council when it was being formed put sufficient stress on those possible problems, which have become more evident as time has gone by. The answer on that score would, I think, require much more extensive discussion than I have time to devote to it this morning, but I think that one of the things I would say is that the experience does support my contention that there should be at least one completely independent institution which has research as its top priority and that is one of the problems that the experience of the Council points out. I also suggest that if such an organization has freedom to reject government contracts that would tie it down too much, and it would have, because I think it is easy to achieve, then you can, I think, get around some of the problems you raise. If a government is not willing to sustain an organization at all that is likely to have an independent view, then I think as I say at the end of my submission Canadian governments would be demonstrating a lack of self-confidence that other governments have not demonstrated.

Senator Grosart: The problem as to public hearings is this: the Government, if it has a report from the Economic Council, will have a very good answer to give anybody who says "You should have public hearings." It will simply say "The Economic Council has gone thoroughly into this question for months". This is what happens. It certainly happened in the case of the Glassco Commission. How many recommendations of the Glassco Commission have the government implemented on that basis?

The Chairman: At least over 100.

Senator Grosart: But nobody asks how many have not been implemented or how many were no good.

Professor Burke: The comment I would like to make is that whereas one or two people appear to have reacted to your question that it was going too far, I would suggest that it does not go far enough. I believe that one of the weaknesses of the terms of reference of both the Economic Council and the Science Council is that they are required to come up with recommendations.

The Chairman: They are not required to come up with recommendations. The Economic Council is not required to come up with recommendations.

Professor Burke: But they have so interpreted their terms of reference, and I am watching their actions rather than their terms of reference. There is need for a person such as a research co-ordinator to make sure that more than one recommendation is made, that there are alternatives offered from which a choice can be made and that there is an effectively independent sort of institution providing research advice to the government.

Senator Yuzyk: Is this why you are recommending this new research in thinking?

Professor Burke: I do not recommend it. I took that out of Hansard quoting it very carefully word for word. And I suggest this is perhaps what is needed for such an institution to have any worthwhile effect on the long-term meaning of democratic government as I see it.

Senator Yuzyk: That is why you mentioned a "monolythic Science Authority".

Professor Burke: If I read it correctly, the word "monolythic" is not here. What page are you quoting from?

Senator Yuzyk: This is from page 20.

Professor Burke: You will notice that in the last three lines before 2. 12 I have said "In Canada, it seems important to avoid any monolythic Science Authority:". This is precisely what I mean. If you have a monolythic Science Authority charged with the task of administration of large sums of money for large science projects, the short-term considerations will always drive out long-term considerations, and I am quite sure that experience will bear out this point.

Senator Yuzyk: But why bring in the thinking institute?

Professor Burke: There I was merely quoting *Hansard*.

Senator Yuzyk: I thought all researchers did a lot of thinking.

Mr. Mardon: It could be a very great mistake to think that.

Professor Burke: Certain terms of reference were given to a particular study, and I merely quoted Hansard in this instance. Now if you want me to expand on what I mean by "plurality of organizations" I would be very happy to do that.

Senator Yuzyk: In reference to this discussion?

Professor Burke: I do not have the competence in the areas of the social sciences that Professor English has. I was more concerned with the long-term innovative processes relating to engineering and the natural sciences. It was a pleasant surprise this morning to learn from Dr. English that they have some common problems, but I do not feel competent to correlate these two.

Senator Grosart: But I think your comment about monolythic authority or a monolythic science authority is begging the question. It seems to me that the situation in Canada would favour a science authority fully adapted to the requirements of a science community.

Professor Burke: I do not know what this phrase means.

Senator Grosart: With all respect the word "monolythic" is meaningless in political terms. As I have said, this is a form of begging the question. If you were to say "a wonderful science authority" then it would be a different matter.

Now, Dr. Lukasiewicz, you make a definite recommendation that a monolythic science authority should somehow reduce the proportion of funding of basic science to below 10 per cent and it seems to me that in Professor Burke's brief he was speaking in very laudatory terms of the Japanese achievement because 30 per cent of their funding is for basic research. Is there a contradiction here?

Dr. Lukasiewicz: My use of 10 per cent is based on the American practice, but I think the basic point is that basic research really is available to everybody. This is one type of information that is generally available and it is certainly recognized that it is not related to geography or to a nation or to a country. It is truly generally available. If a Canadian scientist does basic research, you will find that he wants to publish his research not in a Canadian journal because very few people read these, but in an American journal. I speak from some experience of my own in this regard. So, as I say, basic research is available, but applied research is a different matter. It is not always something that can be transferred by print.

Senator Grosart: If basic research is not related to any particular country, why would you recommend that one particular country should establish a ceiling?

Dr. Lukasiewicz: Because of the deficiency in other areas. The problems that exist in Canada are not problems relating to basic research.

Senator Grosart: Are you suggesting that Canada should adopt a different posture concerning research in the R & D sector from that adopted by other countries?

Dr. Lukasiewicz: I would suggest it should be similar to the United States, that is with a larger emphasis on applied research and development.

Senator Grosart: Are you suggesting a global figure of less than 10 per cent?

Dr. Lukasiewicz: That is the figure corresponding to the present support for basic research in the U.S., and I have recommended that, in Canada, the basic research should account for a smaller percentage of funds. In view of the accessibility of basic research, I believe that Canada could afford a smaller fraction of basic research than the U.S.

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Senator Grosart: It must be significant at the moment if you make it as clear and definite a recommendation as you do.

Dr. Lukasiewicz: Only that it does relate to present realities.

The Chairman: As a fair Canadian participation in the international pool.

Dr. Lukasiewicz: The point is that Canada is in an extremely good situation to have accessibility to basic research. It has a much better one than France.

Senator Grosart: Better than Japan?

Dr. Lukasiewicz: Certainly, very much better than Japan.

Senator Grosart: Why?

Dr. Lukasiewicz: Because it speaks English, largely.

Professor Burke: So do the Japanese.

Dr. English: They tell you they do.

Professor Burke: I might preface a comment by saying I do not know to what extent Dr. Lukasiewicz and myself are divided by semantic difficulties. I feel that the kind of classification of basic research reported by Dr. Oshima's paper in Cambridge is a very selfish one. It does appear to result in communications of international validity, but it is undertaken by industry and two-thirds of this is undertaken by industry on the basis that they want to have confidence in house sufficient to enable them to judge what is best for them—to import or not to import, or to do it themselves. We do feel you cannot do that.

My point is that you cannot buy off the shelf.

Senator Grosart: You cannot buy without knowing what you are buying.

Professor Burke: It is very dangerous to buy a pig in a poke. That is what I am suggesting, and if the Japanese experience is any guide, we need more of this here in Canada.

The Chairman: I wonder if Professor Janstch would care to comment, with his international experience.

Dr. E. Jantsch (Consultant, OECD): On what aspect of this rather complex situation?

The Chairman: I did not warn you. Perhaps you could come in later and give some gener-

al comments in the light of the discussion which is going on here.

Dr. English: I think Japanese experience—and I approach this as an economist—has shown that in their working they have had a fantastic growth of performance. I think the Japanese experience is very difficult to draw lessons from.

Professor Burke: I agree.

Dr. English: Because there is almost unanimous relationship there between industry and government, and I find it very difficult to imagine that sort of relationship being developed in a North American setting.

Senator Cameron: You might add, between labour and industry.

Dr. English: Yes. The most important difference we have to start from, in making comment on what was done in the past, and in making any comment on what was done in industrial research and development, is that we are very much influenced by the presence of so many international companies. We get so much of our research and our technology from that association.

The Japanese have resisted that kind of relationship, though it is significant that they are finding that, in order to keep up in the technological race, they are now devising ways in which foreign companies can participate more. That is the strongest motive for bringing in American and other foreign companies.

It is very difficult to derive any lessons from Japanese experience in this area, given the state we have achieved in the international economy at this time.

Senator Grosart: It raises another question.

Mr. Mardon: I feel a little submerged by the sophisticated professorial attack—the meaning of sophisticated is "calculated to deceive".

Senator Grosart: Who is sophisticated?

Mr. Mardon: The professors:

Senator Grosart: Good. Not me.

The Chairman: I wondered, with the definition that has been given.

Senator Grosart: So did I.

Mr. Mardon: It is true that one must maintain fundamental or basic research in order to appreciate what is going on in the world in general, and this is particularly true of corporations as well as of countries.

The guidance of this basic and fundamental work, the choice of what to do, is the key thing; and this depends upon very high senior people, and it is in this area that our industry in Canada can perhaps be improved.

I would like to defend, in this instance, the National Research Council, which seemed to be continually under attack. From my experience as an industrial scientist of a good many years, I think the research done in the NRC, in Atomic Energy of Canada—whose laboratories are excellent—and other government laboratories is equal in most cases to the best done in American universities, and it is often done better and more efficiently. If you want to see inefficiency at its most rampant. Very often you will see it in a United States research laboratory.

I do not think we can countenance balancing the body in the way the professor suggests, by arbitrarily cutting down something which may be working well, simply because some other part is not big enough What we ought to do is look at the reasons for development in research and development being behind and sorting out those reasons, trying to do something about them, rather than deal ing with them on a doctrinaire basis.

Senator Grosart: I have one question to Professor Burke. On the first page of your brief, in 1.2, you say that the evidence we have had—the 9,000 pages—shows selection and bias.

Professor Burke: Yes.

Senator Grosart: And you suggest it is partly because of the way briefs have been invited and partly because of the pattern of Canadian life.

Professor Burke: Yes.

Senator Grosart: I would be very interested if you would indicate some of the organizations we should have heard from. Yesterday, at Waterloo, which you know very well...

Professor Burke: I do not know it perhaps as well as I should and I should perhaps give an explanation, for Dr. Mardon's benefit. I am a very recent academic. My major experience is in research in large corporations, and I am really an industrial research person who was directed to university because I think, as you do, that their kind of research can be improved upon. Now, if you would continue.

Senator Grosart: The reason I asked this question is that three students asked me at Waterloo yesterday how much discussion has been going on in this Senate committee about federal funding of research in biochemical and biological weaponry. I replied there had been none, as far as I knew. Then they said that was what was inherently wrong with the situation, that they were all for research of the other kind. This remark of yours raises the point. We have not heard anyone raise the question of funding on chemical and biological warfare waponry. Is this a bias, if we did not call somebody in, or call the students, or what is the bias?

Professor Burke: Speaking in terms of sophistication, as defined by Dr. Mardon, indeed this would be a bias; but I would not suggest that students are necessarily well informed persons for the purpose of this particular inquiry.

What I am talking about here is mainly that when you are calling upon everyone who now runs a research organization in Canada to talk about his research organization, he will talk about what is good for his research organization. That is what I mean by bias and selection. It is extremely difficult to find people in Canada who know anything at all about research and who are not involved in defending an existing research organization. I happen to be in the happy position that I do not belong to any existing research organization.

The Chairman: Yet you said in your opening statement that you were biased.

Professor Burke: Of course I am biased. I am biased as a student of the innovative process, and this is a bias you have not heard from, and this is why I took time to submit a brief.

Senator Grosart: Do you suggest a further list of witnesses we might spend the summer with?

Professor Burke: If you would give me notice of that question, I could suggest at least five.

Senator Grosart: This is a serious question.

Professor Burke: I appreciate that, senator.

Senator Grosart: Because the science community is already looking over the witnesses and the evidence we have had and it is finding gaps. I would be very interested in knowing what the gaps are. I don't want to spend the summer sitting here, but I would be interested in at least knowing where we have missed the boat, if we have.

Professor Burke: You appreciate that your question would involve a tremendous amount of work which I have not carried out, senator. I have carried it out to the point of satisfying myself that you have not heard extensively from people representing my own particular field of the innovative process. That is why I submitted this brief.

The Chairman: If they were not heard, why did they not submit a brief?

Professor Burke: Possibly because they do not exist. This is a fact of Canadian life. I am not saying it is anybody's fault.

The Chairman: You are saying that we did not hear from non-existent people.

Senator Cameron: We have had many submissions, Mr. Chairman, which have referred to the need for greater emphasis on the innovative process. In this connection, I should think that there has been discussion of the innovative process.

Professor Burke: There has been such discussion, senator, but not from the point of view I would call full-time students of the innovative process who, to my knowledge, number about four or five in Canada.

Senator Cameron: There are people who are paying huge sums of money for research and development who would like to see more money being spent on the innovative process than is being spent. But I would say it is not fair, nor accurate, to say that the innovative process has not been discussed before this committee.

Professor Burke: I did not say that.

Senator Cameron: That was the inference I drew from what you said.

Professor Burke: This was not my intention.

Senator Kinnear: Mr. Chairman, both Dr. Timlin and Professor Burke spaek of the quality of life in their briefs. I was delighted to hear Dr. Timlin refer to the assistance to people whose instruments for the solution of social problems had been eroded. In her last sentence she says that, in general, the aim of welfare should be the establishment of conditions which can in time eliminate the necessity of welfare programs for all except those

persons whom chance or congenital mischance has made incapable.

I wonder what you consider "in time", Dr. Timlin? Do you think of that as a long or a short term?

Dr. Timlin: I think of the longer term. It seems to me a great deal of our research is concentrated on the immediate future. In setting up a tentative program for studying the development of the human child after infancy, which has apparently been so much neglected by our sociologists, I have a feeling that it is possible that a great many of the difficulties that we find in fitting people into the economy and into social life might be related to the frustrations and privations, and things of that kind, that are found in our slums.

I have named a whole battery of research people and I have proposed just certain pilot nurseries to be set up. I am not asking the Prime Minister to establish day nurseries all over Canada. All I am asking is for some pilot studies there.

The Chairman: He might get married, if he were to establish those.

Dr. Timlin: Well, that would be fortunate for some woman.

Mr. Mardon: Are you suggesting, Dr. Timlin, Proverbs 12 and 6: Train a child in the way he should go and in his old age he shall not depart from it?

Dr. Timlin: No. Have you read my brief

Mr. Mardon: No.

Dr. Timlin: Well, my concern is not only with the normal children, but with children from the flea-ridden slums. As far as the normal child is concerned, our hospitals have already solved the problem of not having to close 100 beds in the summertime. The nurse brings the baby and drops it in the crêche at seven in the morning and collects it at three. There are plenty of places like that where you can find out about the normal child coming from the reasonably advantaged home. I am thinking of the child who comes from the flea-ridden, rat-ridden slums. We know something about protein starvation, for example, but we don't know very much about undernutrition in those early stages.

I point out in my brief and in this study that was produced under the auspices of the Psychological Association that, while large grants went for the childhood and adolescent years—$100,000 and up, and modest research grants, from $25,000 to $100,000, went for infancy, maturity and old age, nevertheless, not one single solitary cent was spent at the time on the development of the human child.

Being of Irish descent, I do tend to include in things I write something floral from time to time. However, I usually remove the flowers from the compositions before printing them. Nevertheless, I have left one paragraph in the brief about the relative importance of the human child who, as a molecular and electronic organization, is probably one of the most wonderful things in the world—and not only in our world but perhaps in many worlds.

We spend money to go to the moon. The moon is a barren place, but we put an awful lot more money into the moon than into the study of the actual physiological and mental development of our young children.

I don't know how long it would take to do the research involved here. It might take as long as the five years that they are putting into the basic research aspects of the international biological program. But I do think, if you can set these crêches up—and I have suggested they be attached to university hospitals under provincial auspices in order to escape the suggestion that there is a constitutional infringement—they would comprise a great area of research, and one which remains to us as never having really been tackled in any large way.

I was talking to Professor Burke before the meeting about a book I picked up on the electronic circuits of the brain. Two years ago I missed a meeting at Carleton in order to look it over because I found it so very interesting. But that book only went as far as the octopus. It seems to me that there is a large area to go beyond that in order to find out what is this creature man, and what are his potentialities and how we can upgrade people from slums in terms of their capacity to take on skills so that they can come into the school system with a certain amount of pride in themselves and in their backgrounds as is the case with the nice, logical development which is possible, let us say, for the child in the relatively advantaged family.

That is an example of the kind of research I would like to see done, because I think in the long run the GNP might be increased further by upgrading the human input, so that we have the people who could do all the advanced things, and I put that last quotation

in this general thing about the colossal state of the gene pool. The man who wrote it did not think beyond that, but I took it into the environmental situation.

The west, even, has been awfully slow to educate its children. In Great Britain in the middle of the nineteenth century, only a quarter of the children got more than two years in school, and nearly one-half got nothing but reading and writing. It was 1870 before there was an act passed favouring the development of elementary schools outside of the charity schools. It was 1891 before fees were abolished for elementary education in Great Britain. It was 1902 before legislation was passed which favoured the development of secondary education; and it was that same year that the religious requirements for adhesion to the 39 Articles of the Church of England were abolished as prerequisites for getting into British universities.

We cannot be too proud ourselves. I have a copy of a letter of Sir Clifford Sifton in my file written to Manitoba about the turn of the century, in which he was opposing free secondary education in Manitoba on the ground that working people could not afford to send their children to school and should not be taxed for the education of other people.

I will go beyond that, to my own experience. I graduated from high school in 1910 and that is a long time ago. At that time I lived in a very pretty village, with the houses all painted white and even the railway station, on the Wisconsin River, and, as far as I know, there was only one high school in the whole county and there was a great deal of difficulty in getting to it. There was one year I took the train at 7 o'clock in the morning and got home at 9 o'clock at night. Forty people started in my class, and 20 graduated—and that was for the whole county, practically.

We have been very slow to develop our education potential, and I think the biggest thing to be done—and excuse me for being so enthusiastic, but I have nothing to gain for myself from any of it, because I am too old now—is to improve the human potential. I think that the restlessness of our youth at the present time might be assuaged quite a bit in a society which undertook something of that kind. And how long, I do not know.

Senator Kinnear: I think the transportation system and the length of time it takes to get to school have not changed a great deal. In my own area, which is well populated, the Niagara area, some people leave at 8 o'clock in the morning on the bus and do not get home until 6 at night, so they are long hours.

Professor Burke, you say:

> ... I shall concern myself with employment as the main measure of economically desirable results. When employment is of the quality aimed at in the phrase: "the human use of human beings", it will also be socially desirable.

Then in the next paragraph you state:

> Employment as a measure is superior to money, and to productivity, when long time spans are considered, and when it is desired to make comparisons with other nations (except the U.S.) where money values and product mixtures are very different from ours.

Not only do I want you to comment on this, but also to give what you consider the difference between us and the United States in employment.

Professor Burke: I suggested it was less between us and the States than between us and other areas; that is why I said "except the U.S.". But there is a difference, and a substantial and important one, that has a bearing on what Dr. Timlin has said and also what Senator Grosart referred to, and some of the witnesses we have not heard from because few of them exist in Canada—the point that Professor Ben David has stated extensively in comparing the gap between scientific and technological advance in the United States, on the one hand, and western Europe in the last 50 years, on the other. That is that the United States has, for a very long period of time, had a strong tendency to invest in human potential, going right back to the turn of the century and before, and has consistently invested more heavily in educating a greater proportion of its population further and has derived immense indirect benefits from it. I do not think we have derived equivalent benefits in Canada because we have not been equally concerned with investment in human potential. In this respect I agree entirely with Dr. Timlin.

I am not sure if this answers your question. I would like you to expand on it, if you would. I feel very concerned with this point.

Senator Kinnear: I agree that employment as a measure is superior to money and productivity.

Professor Burke: I mean employment in the full sense, distinguishing between underemployment and unemployment as well as between just employment and nothing else. I think this is very significant and this is a point that perhaps Dr. Luckasiewicz has dealt with in his brief, but I have not had the privilege of reading his brief.

We have had in the United States in the last 20 years a grave distortion of what used to be their pattern, that in the order of half or more of their research recently has been devoted to military and space aims rather than to the more mundane but perhaps socially more important aims that research and development and innovation can be sent to. So the numbers that derive from experience are not quite as applicable to us as they should be as models, because we have not the same degree of commitment to military and space effort, and, in my view, we should not have any greater commitment in that area than we have now, but we may, in a compensating way, need a greater commitment to the non-defence areas.

Senator Kinnear: I think there is a great point that the highly educated are in a fine state to go on to be specifically educated, but it is the lower mass we want to bring along and see they are employed or, if unemployable, see what can be done...

Professor Burke: ...to render them employable; and I do not know how many witnesses you have had talk about this problem.

Senator Kinnear: They talked about it very little.

Professor Burke: This is what I meant by selective witnesses.

The Chairman: Perhaps the selection reflects the Canadian population.

Professor Burke: I do not deny it. I said Canadian life is one of the reasons, and not your faults.

Senator Belisle: Mr. Chairman, my question will be directed to Professor English. I would like to compliment him on his presentation, but I noted what was said by Mr. Mardon regarding professors, so I think I should include you all in my compliments. You all did very well.

On page 2 of your brief you say:

> Secondly, social research is more politically sensitive. In some highly developed societies it is still a rarity for academics to challenge the system head-on with social criticism.

My question is this: In using the phrase "head-on criticism" are you referring to that which took place at the University of British Columbia and at Sir George Williams University in Montreal, and are you saying it will do more for the advancement of social science by focusing the attention of the press and the public on it, or can you suggest some way by which we can avoid these head-on collisions?

Dr. English: Senator Belisle, I think the incidents to which you refer did not constitute social criticism. They were social dissent, but not criticism.

Professor Burke: They were caused by frustration.

Dr. English: Yes, frustration—some of which might be justified, but certainly not all. Of course, the methods used were highly questionable. No, in that statement I was referring to the activities of the social scientists themselves. I was referring also to the circumstances that apply not so much in Canada as they do elsewhere. In Canada the criticism of government policy by social scientists is of relatively recent origin in the sense that there has been much more of it in the last decade. The reason for that is simple to find, and it is in the fact that there are now many, many more social scientists in Canada. Only seven or eight years ago my own Department of Economics at Carleton University had four people in it, and now it has 20. That is not too atypical. It reflects the growth in the universities—in the undergraduate bodies, and now in the graduate schools. Therefore, there is much more of a foundation for all of these activities that we refer to than there used to be. There is a larger supply of talent around. My statement has to do with the way in which we employ that talent in government and outside government.

Senator Belisle: May I say, professor, that you have done very well. You have convinced me that we need greater research in the field of social science. Thank you.

The Chairman: I wonder if we could have a more detailed history of the ten million dollar crime?

Dr. Lukasiewicz: Mr. Chairman, I was referring to the transonic and supersonic wind tunnel, which is a five-foot tunnel that was built at Uplands. It was finished many years after I left Ottawa, and it cost twice as much as it was supposed to cost. It is a facility that was designed for the support of industrial testing. This was at a time when the C-105 aircraft was being developed, and the tunnel was designed specifically to be an efficient industrial wind tunnel. In spite of the cancellation of the "Arrow" project in 1958, the facility was built. Since the policy of developing advanced military aircraft in Canada was discontinued after the "Arrow" cancellation, there was no longer a requirement for this type of facility in Canada.

The case of the Uplands five-foot tunnel is an interesting one because, in fact, the concept of this particular type of facility was first developed in Canada—and yet could not be effectively applied there. In the U.S., several wind tunnels of this type were built by the industry and were completed many years ahead of the Uplands installation, as pointed out in the Glassco Report. The delays in the completion of the Uplands installation were mostly due, I would say, to indecision and split responsibilities among several government organizations involved. Of course, when it was finished it was found to be no longer required.

The Chairman: That is one result of research.

Dr. Lukasiewicz: The result was fully predictable as soon as the "Arrow" was cancelled. Also, the information to be obtained from such a wind tunnel for a single aircraft project could have been obtained from facilities available in the U.S.. To obtain such information, one does not have to have a wind tunnel of one's own.

I would also like to comment on Senator Grosart's remarks having to do with the contract operation. This is a mode of operation by government that is very seldom used in Canada. Incidentally, it had been proposed for the Uplands facility. It is rather remarkable, on the other hand, that it is a mode of operation that is almost universally used in the United States.

I left Ottawa to run a laboratory operated by a private company on contract to the U.S. Air Force, and I found this to be a rather advantageous type of operation. I think also, in relation to various establishments and organizations, that the answer to bias is competition. With contract operation, one can always have a choice of contractor or one can give contracts to two different companies and have a different answer from each. One can select whichever one wishes, but there is competition. I think competition is extremely valuable in the management of anything we are doing. In an in-bred system of in-house operations, one never has competition, and that is part of the trouble that was referred to here earlier.

Professor Burke: May I establish the link between that statement and my own brief by saying that "competition" and "plurality" are synonymous terms for all practical purposes.

Senator Grosart: There is a question I should like to ask in respect of the Root-Mardon brief. On page 11 the suggestion is made that there should be a survey made to compare the funds generated by the different industries in Canada and the funds allocated to them for research and development. In the next section it is suggested that above a certain annual income such companies should be compelled to carry out "a due proportion of their research and development work in Canada.

Do you think that can be made to stick?

Mr. Mardon: This is a political point, to which we would defer to your superior knowledge and judgment, but we should aim, I think, at establishing the maximum competence in both quality and quantity in our country. If it is politically feasible to do what I suggest, and if some financial yardstick can be devised so as to avoid hardship on relatively small companies then I think large companies should be requested, if they do business in our country through subsidiaries, to do a portion of their research and development in our country, perhaps in some specialized area, and establish what others have called centres of excellence in these various areas.

Without mentioning specific companies, we are thinking of very large corporations that do no research at all in Canada.

Senator Grosart: We have evidence, of course, that some companies already have this policy. There are companies which, as a matter of corporate policy, fund research in proportion to the percentage of their sales in Canada. Would you suggest this as a Canadian policy guideline...

Mr. Mardon: Yes, I certainly would, sir.

Senator Grosart: ....for the behaviour of subsidiary companies?

Mr. Mardon: Yes, who are corporate guests in the country.

Senator Grosart: The objection that you might care to comment on if you are going to do this in Canada is that you have to do it with everyone else. You wind up with research development in Peru, Chile and all over the world. Would you say that this should be specifically related to Canadian policy as far as the companies are concerned or should it be a global policy?

Mr. Mardon: I would start in Canada, sir, and see how the others follow suit.

Mr. Root: I think we are trying to point out that there is a study necessary if this idea is to be pursued. Perhaps we can call on the economics experts in the matter of a dividing line in which this could be levered.

The Chairman: You want to comment?

Dr. Lukasiewicz: I should like to suggest to my colleague that the problem of performance of R & D by industry in Canada is taken care of automatically if operation of a subsidiary in Canada is the sole corporate responsibility in that particular area. In other words, if a subsidiary is specialized within the total operations of a corporation, it has to be responsible for the R & D activity related to its own area of specialization. In fact, it could not perform the corporate function adequately for the whole corporation unless it did research in its specific area. No government incentives are required to insure this if the responsibility of the company is, in fact, allocated in that fashion.

Mr. Mardon: I think this is by no means true. Large corporations based elsewhere would buy prime TV time and persuade all Canadians to buy exactly the same product as in the United States.

Dr. Lukasiewicz: I do not believe I have made myself clear. I am saying that if a certain part of a TV receiver is produced by a company in Canada for the whole market available to the corporation, for example not just the Canadian market but the whole North American market, then the research related to this part will be done also in Canada by the Canadian branch of the corporation. This happens, for example, with the United Aircraft Corporation of Canada. On that basis, the R & D related to a product is being automatically performed by its producer, who has the complete responsibility for the development of that part of the hardware, including the R & D.

Mr. Mardon: It would be done contrary to my general experience. I have worked in five different countries around the world.

Dr. English: I would like to second the point that has been made. I think there is a problem in industrial economics. The problem is that many Canadian firms and subsidiaries of foreign firms working in Canada are not working under the same incentive or circumstances as the parent firms or subsidiaries of the firms working inside the United Kingdom. What you need to do is examine the differences between the incentives available to those firms and see which of those need to be buried. As an economist, it is unworkable to impose the kind of direct restraint that you refer to.

Senator Grosart: Would it not be equally unworkable to select certain firms and say that you must do this or that?

Dr. English: The simple thing to do, which we have not done yet, is to encourage Canadian industry to take a world market outlook. There are of course several obvious things that you can do in order to achieve that. One thing would be to eliminate all trade barriers that have forced their way into the world economy.

The Chairman: Provided the others do the same.

Dr. English: Yes, we would have to get devised systems for mutual relations of trade barriers. That is very often the reason firms have a very narrow approach to its R & D and other activities. It is necessary to insure that the incentives available to Canadian industry are equivalent to those available to industries elsewhere. There is no artificial advantage to locating in another country R & D activity that might be carried on in Canada.

The subsidiaries of American firms that I am acquainted with have already responded

to the anticipation of that kind of a world in the future, and would respond more fully if the opportunities were more equal for access to the world market. It seems to me you achieve much the same aim by a much more workable and market-oriented approach.

Senator Grosart: This is Dr. Marques' theory.

Professor Burke: I should like to add to this comment by saying there is an inadequacy at the present time in the existing incentive schemes provided, and that inadequacy, I believe, is so marked that it should be a prime concern of this committee to improve it. You have heard some evidence on this. I have not studied the situation in depth. I am fairly satisfied that present incentives to innovative behaviour in Canada are less than similar incentives in the United States.

Senator Grosart: Are you referring to market or government funding incentives?

Professor Burke: Both.

Dr. Lukasiewicz: I should like to mention one example, and I believe you said it is a good one. This is a rather high technology company which manufactures the Leica cameras. This company has a plant in Canada which I think is the only plant outside of Germany responsible for a sector of research and products and functions exactly on the basis I described. It does very high quality work and takes care of certain components of the products that the parent company markets throughout the world. It does not require any government incentives to do this.

Senator Grosart: There are a good many companies that are doing this in some other countries, yet they are selling their products in Canada but not doing research in Canada. You say the Leica Company has picked Canada to be given a certain responsibility in research, but if you say that this is the only place where Leica is doing it then Belgium, France and others might have the same complaint that we have.

Dr. Lukasiewicz: We are not suggesting that every company should do this in this country of course.

Senator Grosart: Why not?

Dr. Lukasiewicz: It is neither necessary nor feasible. The productive capacity would not suffice.

Senator Grosart: The suggestion in the brief is:

> Above a certain annual income such companies should be compelled to carry out the due proportion...

This is the suggestion we are discussing.

Mr. Root: We are talking about Canadian manufacturers, Senator Grosart, not just marketing products from other sources into Canada. The fact that we are discussing it I think indicates the importance of the point we are trying to highlight, which is maybe the virtue in trying to seek a dividing line somewhere—this may have to be political—above which it is desirable, if you wish to use the word compel.

Senator Grosart: That is: "If you have such and such a share of the Canadian market you come under this new law which we are going to pass".

Mr. Mardon: Such and such a share and such and such a total volume of sales manufactured in Canada.

Senator Grosart: That is a share of the market.

Mr. Mardon: Mr. Chairman, I have one small point that I would like to draw to the attention of the committee. I am sure we might get unanimity from both the Senate committee members and the panelists. In our brief we have drawn attention to one fact which has consistently appeared before in the evidence given before the committee, and which I very strongly disagree with. It is that at some stage around the age of 40 a creative man loses all his creativity. I strongly deny this. It definitely is not true. I have many personal friends, including a few of the world's very great scientists, and some are in their eighties and it is certainly not true in their case. In the brief we have given reasons why. It is very common to find that people cease to produce around the age of 40, but I think these reasons tend to keep these people creative.

Dr. Timlin: May I make one remark in respect to that—keep them out of administration.

Professor Burke: I should like to comment on that by saying that much of the evidence that is misquoted in this connection comes from a misreading of Lehmann's book in 1953 *Age and Achievement*, which in fact does not provide evidence for the contention you have attacked.

The Chairman: On this note of unanimity I think we will adjourn. Before doing so I want to thank you all, and in particular Dr. Timlin.

Professor Timlin: Thank you, Mr. Chairman. It is such a pleasure to meet you again.

Mr. Mardon: I thank you most sincerely, and am only sorry that I was not able to exercise my French.

The committee adjourned.

APPENDIX 180

BRIEF SUBMITTED TO

THE SENATE SPECIAL COMMITTEE ON

SCIENCE POLICY

BY

DR. MABEL F. TIMLIN

A BRIEF TO THE SPECIAL SENATE COMMITTEE ON SCIENCE POLICY

By Mabel F. Timlin

It is not the intention in this Brief to repeat material included in the Report to the Social Science Research Coundil of Canada entitled The Social Sciences in Canada: Two Studies. The intent is rather to supplement that report through discussion of other matters. These will include some discussion of the relations between the natural and the social sciences relating to research and development, of problems raised in this area and others respecting multidisciplinary research, and of the desirability of certain liaison devices in the research structure which can promote the execution of multidisciplinary projects involving cross-disciplinary relationships among the natural and the social sciences. The brief will also include some limited information respecting social science research councils in other countries, some problems raised through the findings of the Macdonald Report, and the special problem of financing the SSRCC in a manner most compatible with the national interest.

Of the listed terms of reference (a) through (d) for the Special Senate Committee on Science Policy, the first three are explicitly directed to matters related to Research and Development. Moreover, very few general statements respecting R&D are made today by university administrators or scholars in the natural sciences which do not emphasize the rising importance of the social sciences in this area. Yet the definition of Development in particular is set out in terms which may puzzle the social scientist regarding his connection with the process. Typically Development is defined as it is in the definitions on page 80 of the Proceedings of the Senate Committee on Science Policy of October 23rd, 1968: "Development is the use of knowledge derived from research in order to

produce new materials, devices, products and processes, or to improve existing ones."

Much of the earlier evidence laid before this Senate Committee appeared to apply the definitions set out for both Research and Development narrowly and have carried at least an implication that the Gross National Product, its composition, and rate of growth, were ends in themselves rather than means to ends seen in a human perspective. Much of the later evidence placed before the Committee has modified the narrowness of this viewpoint, but it requires to be explicitly set out that in both the natural and the social sciences concerns are emerging respecting human beings and the services which they render to each other that cannot be subsumed under the usual definitions of Research and Development or brought totally under the accounting of the GNP. In the words of a book originally published in 1926:

> Economic efficiency is a necessary element in the life of any sane and vigorous society, and only the incorrigible sentimentalist will depreciate its significance. But to convert efficiency from an instrument into a primary object is to destroy efficiency itself. For the condition of effective action in a complex civilization is co-operation. And the condition of co-operation is agreement, both as to the ends to which effort should be applied, and the criteria by which its success is to be judged.
>
> (R. H. Tawney, Religion and the Rise of Capitalism, Penguin Edition, p. 250.)

The convergence which is taking place between the natural and the social sciences is occurring as would be expected on the boundary between the biological and the social sciences. It is most easily elucidated in concrete terms. These will serve to show both the nature of the convergence and an area within which

multidisciplinary research is a necessity for the completion of the research project. Two projects will be examined breifly. The first is already under way and concerns a project directed from the University of Saskatchewan connected with the International Biological Five-Year Program (IBP). The second proposes a program of research related to a possible revision of expenditure structure in the field of the Federal Government's Family Allowances program.

The International Biological Program and the Matador Project:

The subject embracing all the individual projects under the IBP is the relationship between biological productivity and human welfare. Individual projects are organized around a concept known as the "ecosystem." From a global standpoint the best description of this term is probably one drawn from an unpublished paper of Professor J. S. Rowe of the Department of Plant Ecology of the University of Saskatchewan entitled "A Conservation Program for the Matador Area: The Rationale." This reads as follows:

> From the vantage point of satellites the world is seen objectively as a self-contained space ship, a metabolic cell powered by the sun, an ecosystem. Solar radiation stored as chemical energy in green plants flows to animals, to man and to decomposer organisms, reduced and dissipated as heat at each successive trophic level. Nutrient elements also flow and circulate within the ecosystem by characteristic metabolic pathways. The dynamic processes evolve or stand steady through feed-back controls which, when understood, allow manipulation of the system. In this view man is recognized as a functional part of the world, interdependent with all life and with his energy material milieu. He is also seen as searching for an

adaptive culture that fits him to the world, one that expresses his need to create and maintain a sanative environment.

The IBP is a conservation program because its underlying aim is to ascertain the conditions under which the "perpetual productivity" of the world's renewable resources may be assured. From the standpoint of the biological sciences, conservation education (to quote Professor Rowe again) "aims to train social biologists oriented to people as well as to environment, aware of the ecological consequences of man-made changes, able to study the sociological and economic aspects of renewable resources and to prescribe management practices which constructively contribute to human and environmental health." The ecosystem concept is the chief methodological tool of the IBP, though the period of five years is too short to achieve solutions to many problems. But "The concepts and techniques refined in the IBP are the key to the future, as man attempts to rationalize his use of resources and to discover his optimum niche in the scheme of nature."

The operative word for the social scientists here is "optimum." It implies an adjustment of populations, regional and global, to the resources available for human survival in a degree which permits "high-quality living." Anthropologists have a very special admiration for humanity as a species based upon a degree of adaptability in the species which has achieved survival under conditions as different as those among the Eskimo in the Arctic and the Bushmen in the Australian deserts. But these adaptations were made over long periods of time through a combination of natural selection and a rational adaptation of means to ends. We do not have these long stretches of time today, in a world in which in the face of still falling death rates world population is estimated to be

presently increasing at the rate of approximately 70,000,000 persons a year. In such a world situation there are possibilities of large areas of production in which growth of the GNP, national or global, may be sustained for a period only by a sacrifice of the future to the present. Basic research is clearly a necessity here, and Science Policy must recognize these possibilities.

The International Biological Program is organized for the purpose of assembling this basic information within the area of renewable resources. Projects have been organized in more than sixty countries, although it has not been possible to get an estimate of their total number. Several IBP sections have been set up and appropriate committees organized. Three are related to productivity in specified types of environment: terrestial, oceanic, and fresh water. The first is by far the most important and projects have been classified here under four land types: tundra; arid lands; woodlands; and grass lands. Among several other IBP sections is one organized (or to be organized) under human adaptability.

In Canada major emphasis is being placed on land and forestry projects. The Matador Project is a grasslands project situated on an area of virgin land of high productive capacity near the town of Beechy, Saskatchewan. This project absorbs somewhere between 20 and 30% of the total Canadian effort under IBP. Description and analysis of the project will be kept to as brief an account as possible within the objects of the description and analysis.

Dr. King of the Organization for Economic Co-operation and Development, when he first appeared before this Committee, complained bitterly respecting difficulties encountered by OECD in the organization of multidisciplinary research projects and imputed these to the naiveté of natural scientists, arrogance of economists, ignorance of politicians, and complacency of civil servants.

The Matador Project on the other hand, after some initial difficulties, has been so successfully organized and is so enthusiastically supported by those engaged in the research enterprises involved in it that it has become, as it were, a model for similar grassland studies sponsored by IBP in other nations.

The project itself is being carried out on about a section and a half of land so nearly uniform in its characteristics that it is considered possible biologically to think of it as a single ecosystem. As a means of isolating the area from outside influences, it has been surrounded by a buffer zone of other virgin land. Moreover, in order to ensure some comparability of results for IBP certain grassland projects in the United States and Mexico have been set on sites with soil of comparable characteristics. Part of the Matador site has been left as natural grassland, part sown to perennial grasses, and part is a wheat field. That is to say, there are three ecosystems to be studied.

The project has been organized by the Canadian Committee on the International Biological Program (CCIBP) in co-operation with the National Research Council and the University of Saskatchewan. It is being conducted with assistance from the Saskatchewan Departments of Agriculture and of Natural Resources and the Canadian Wild Life Service, and with the assistance also of representatives from the Canada Departments of Agriculture, of Transport, and of Forestry and Rural Development, the Saskatchewan Research Council and the Universities of Manitoba and Calgary. Research enterprises contributory to the Matador Project are being carried on at the two universities named. About one-third of the financing comes from the National Research Council through CCIBP and is expected to total for the five years from about one and a half million to two million dollars. By the calculations of Dr. R. T. Coupland of the Department of Plant Ecology of the University of Saskatchewan and Director of the Matador Project -

through whose courtesy most of my information has been obtained - it appears likely that direct and indirect costs to the University of Saskatchewan may parallel in total amount the contributions of the NRC. Dr. Coupland states that about 80% of his own time is now absorbed by the project and that there are now about 100 persons directly involved in research connected with the project. This implies a considerable number of supporting personnel also, especially in those months when participants will be living very largely on site. The research staff, while they may come from a number of other institutions, have been in large proportion recruited from the two campuses of the University of Saskatchewan at Regina and Saskatoon.

Research has been planned in four areas: producer research covering productivity studies by plant scientists of plant life in each of the three subsidiary ecosystems; consumer research or biological studies of invertebrates, birds, and large and small mammals getting their livings either primarily or secondarily from the ecosystems; studies relating to micro-organisms, including both microflora and microfauna; and last, abiotic studies relating to photosynthesis, water-cycling and soil nutrients. The above summary cannot, of course, in any way reflect the extraordinary complexity of the enterprise.

The most difficult area of staff recruitment has been in the abiotic area. Information from the Director has been to the effect that research in Canada has paid much more attention to the plant and its environment underground than aboveground. It is undoubtedly this situation which has made it so very difficult to find specialists for the project in the fields of micrometeorology and photosynthesis. Yet the former is a specialist in the ground-level temperatures which are the most important to photosynthesis and the latter is the chemical process which makes all life possible on this planet. The possibility of gaps in the research structures of the natural sciences emerges here and may be related to certain past policies of NRC.

The organization of a multidisciplinary project is not an easy matter even in the natural sciences. In its initial stages the Matador project ran into organizational difficulties. The paramount necessity was, of course, to find the highly qualified specialists required for planning and research. Here the organizers ran into the common excuses offered to avoid such enterprises: scholars approached were much too busy with their own programs, felt that group research was not sufficiently rewarding to the individual, wondered why the project, if a feasible one, had not already been carried through elsewhere, and believed it unlikely to get the necessary financing anyway. They did, however, consent to participate in the formulation of a hypothetical plan. During the planning interest was aroused and participation began to seem possible. Data supplied to the writer indicate that of 26 professionals involved in the enterprise in 1967, 11 had been involved in planning but not research, 13 had been involved in both planning and research, 8 had been consultants involved in planning only, and 2 were postdoctorate and research associates involved in research only.

The paradox attaching to the earlier objections is that participants are acquiring international reputations hardly possible for them to acquire as individuals working alone each in his own area of specialization and unattached to the larger plan. UNESCO, for example, has become interested in the project, its representatives have already visited the site, and a meeting, international in character and sponsored by UNESCO, is scheduled for September, 1969, on the site of the project.

As for the global International Biological Program, it had been thought originally that basic research might be continued under the auspices of the plan after the five years were over, but at the UNESCO Intergovernmental Conference on

the Scientific Basis for Rational Use and Conservation of the Resources of the Biosphere held in Paris in September of 1968 a decision was made to terminate the original program at the appointed time and to substitute a follow-up program involving the application of findings already made to the management of renewable resources in the interest of assuring perpetual survival of productivity capacities. Again in the words of Professor Rowe, "The principal aim of the Conference was to focus the attention of Member States on the need for a comprehensive plan for multidisciplinary research and education on ecosystems, both intensively managed and wild, including not only pedology, biology, medicine and meteorology, but social sciences and human ecology".

For the Matador Project this change to applied research will mean the enlistment of co-operators over a large surrounding area who will under advice manage their land areas in the interest of maintaining their perpetual productivity.

Time has a different aspect for the national state than it has for the human individual. The life of the national state may be expected to extend into the indefinite future. For this reason not only is the state the guardian of justice, order, and well-being for the contemporary generation; it is also the conserver of the inheritances of future generations. If its objects include (as it seems they should) protection of the capacities of renewable resources for perpetual productivity, then the normal formulations of the economists' cost-benefit analyses cannot have universal application. The end or benefit is set by the state. If there is more than one way of achieving the end, calculations will concern only comparative costs.

The writer knows of only one concrete example where steps have been undertaken by a national government to ensure perpetual productivity of land areas. In the Netherlands when land has been reclaimed from the sea it is held under state management until it has been raised to a high level of productivity.

Then it is offered for lease at annual rents less than the estimated annual charges sufficient to return full costs of reclamation and development. Competition is extremely keen to secure these lands. From the numbers who apply, the government selects those tenants considered to be the best agriculturists. The tenants need have no concern for the permanence of their leases so long as their agricultural practices remain at their initial high level of competence. The inference is plain that in the social accounting of the state assurance of a continued high level of productivity on these lands offsets some of the expenditures incurred by the state.

Where the titles to land are absolute in the tenant's right, the problem of regulation is more difficult. Moreover, there are situations within which some variations from the aim may be justifiable. Prairie farmers are, for example, making adjustments to the current wheat marketing situation in part by restricting wheat acreages and in part by using less fertilizers on their lands. In a crisis situation the latter adjustment may be as defensible as the first and its effects compensated when the crisis is over. But in the face of a structural change in market demans likely to be continued, this adjustment pursued over a longer term could be seen to be against the national interest. The services of market and agricultural economists would be necessary for diagnosis.

Pollution of land areas, air and water is defined by ecologists in terms of retardation of the nutrient and energy flows sustaining all organic activity. Increasing pollution, means increasing retardation. Regulatory prescription adopted by the state or its subdivisions may arrest the increase, but rectification of existing levels brings in more complex problems. Failure to have imposed regulatory devices earlier involves the state or its subdivisions in some responsibility for the situation. To impose the total costs of reclamation on the sources primarily responsible may have damaging effects of its own on

employment and production. The shorter the period of time over which reclamation is to be accomplished the higher the costs are likely to be. The pace of such activity economically the most feasible will need to be balanced against the degrees of present danger. The decision-making process in this area as in others is a prerogative reserved for governments, but it requires to be backed by multidisciplinary research by natural scientists, engineers, and economists.

Among economists today a number appear to shy away quite violently from the very idea of multidisciplinary research. Involved in this revulsion there appears to be a fear of lack of rigour and discipline in the conduct of projects of this type. Evidence from the Matador Project suggests that this fear has little foundation and is itself based upon a misunderstanding respecting the nature of multidisciplinary research and the forms it can take in an effectively organized multidisciplinary project.

Experience at the Matador site suggests the following as one set of conditions which can make a multidisciplinary project successful:

1. The area around which the multidisciplinary research is organized must be one important enough to gain the interest of scholars from the various disciplines involved;
2. The scholars whose services are sought after should be brought into the planning at an early stage and the planning should be meticulously carried out;
3. The project should be one under which it is possible for the scholars involved each to use the methodology appropriate to his own field of interest;
4. It should be recognized in this type of undertaking that results also may be multiple and may take the form of a <u>series</u> of recommendations for action or alternatively for a <u>system</u> of related actions.

There is no reason whatsoever to believe that the scientists connected with the Matador Project are not exercising the same degree of rigour and precision which they typically exercise in their unidisciplinary research. There is on the other hand reason to believe that the enthusiasm engendered by the progress of the project, the attention it is receiving internationally, and the profound belief evident in the validity of the total International Biological Program must all combine to enhance creativity and the care and vigour with which the special areas of research are pursued by individual scholars each using his own methodologies for discovery.

The convergences of the life sciences, on the social sciences are paralleled by an opposite convergence of the social sciences on the life sciences and the nature of that convergence is discussed below.

The Social Sciences, the Life Sciences and the Federal Family Allowances System: On pages 106 and 107 of the report The Social Sciences in Canada during a brief discussion of the committee on the Biological Bases of Human Behavior of the American Social Science Research Council questions concerning the relationship which might exist between early environment and the physiology of brain development were posed. It was pointed out there that the committee was planning "a number of training programs and conferences to disseminate among social scientists greater knowledge concerning biological concepts and methods." The report of this committee in the Annual Report 1967-1968 of the American Social Science Research Council makes the following statement.

> The committee is concerned with facilitating communication between biological and social scientists, and with improving the biological education of social scientists. Lack of training in biological sciences has been a major obstacle to increased utilization of their theories and concepts in social and

behavioral research. Scholars who have identified relevant biological aspects of such research and who have sought to improve their competence in the appropriate biological disciplines have found this difficult because of inadequate background.

In the March, 1969, number of the American Social Science Research Council ITEMS, pp. 10-1, descriptions are given of a five-day conference on Appraisal of Biological Training for Social Scientists held in Puerto Rico in February, 1969 and of the nature of the ad hoc groups which prepared reports on the central topic. In the same number, p. 16, an announcement is made of a Summer Training Institute on Genetics and Behavior for Developmental Psychologists to be held at the University of Colorado, June 16-July 25, 1969 under the auspices of the Committee on the Biological Bases of Human Behavior and supported by a grant to the American SSRC from the National Institute of Mental Health. The March, 1969, conference in addition to attendance by the five members of the committee was also attended by 28 social and biological scientists "all of whom were acquainted with some aspects of the relations between these two major branches of science." It must be added that no examples have been encountered respecting efforts of biologists to acquire training in areas of the social sciences in which they would need to be versed if they are to be able to fulfil the functions Professor Rowe lists for social biologists under conservation education. So far as is known no special efforts have been exerted in Canada to bridge the gaps in training from either area of convergence. It is often pointed out that the traditional organization of universities lends itself, to the development of such gaps. In the words of the OECD publication Government and Allocation of Resources to Science"(p. 19), "...institutional rigidities and compartmentalisation in the universities may lead to the neglect of new fields

especially if such fields do not fall within any one discipline."

The Macdonald Report has approved the suggestions set out in The Report on the Social Sciences in Canada respecting the organization of the Social Science Research Council of Canada as an agency for organizing multidisciplinary research among social science disciplines. It is respectfully suggested to the Senate Committee that in the structure of organizations for the support of research in Canada somewhere there should be a provision promoting liaisons where necessary between the SSRCC and the life sciences for the planning and staffing of projects requiring co-operation between the two science fields. In the Netherlands there are three autonomous bodies or councils outside the two financing agencies. That is, there are the Physical Sciences and Medical Sciences Councils as non-granting agencies as well as the Dutch Social Science Council. Would it be possible in Canada, for example, to have a permanent committee of biologists appointed by the Science Council for the specific purpose of maintaining relationships with the Social Science Research Council of Canada in the area of crossdisciplinary research? It is important that it be a permanent committee since the research structure should permit the initiation of cross-disciplinary projects by either the biological or the social sciences. There are possibilities also of a need for liaisons between the earth sciences and the social sciences because of the changing position of geography, physical and human, in Canada, but these have not been explored.

It was proposed earlier to use the Federal Family Allowances Program as a point of departure in sketching out tentatively a multidisciplinary project directly involving both the biological and the social sciences. The origin for this proposal lies in a report entitled Canada's Psychologists and based on a survey prepared for the Science Secretariat of Canada under the auspices of the Canadian Psychological Association. On page 83 of this report there is a Table

entitled "Levels of Support of Specialties within Areas of Psychology." This table shows under developmental psychology "Significant support ($100,000 or more)" for "Childhood and Adolescence," "Modest Support ($25,000 - 100,000)" for "Maturity and old age and Infancy," but for the "Nursery and pre-school child" "No support." The italics are mine. The weakness in the research structure here is plain. It is well known that the human child at the end or approximately that of his first year has the full complement of brain cells that he will ever possess but that the years immediately following come next in importance in terms of the development of the brain cells themselves and the nature of content and patterns established. Here again possible inadequacies of training of psychologists in the biological sciences come in. But the area omitted is so important that it deserves a thorough canvassing by both biologists and psychologists, and by medical specialists in the anatomy and physiology of the brain. The Chairman of this Senate Committee during the proceedings once made a remark to the effect that we probably know more about the biology of fish than we know about the biology of man.

It is, however, the interaction between the child's genetic endowment and his environment during these early years which determines his later capacity to achieve his full potentialities as a human being. It has been noted that the Economic Council of Canada in co-operation with the Vanier Institute is undertaking a study of the pre-school child. Dr. Arthur Smith has called it an "assessment." This could provide a significant beginning but an effective program, it seems to me, would require large-scale organization of the type characteristic of Canada's projects under the IBP, and utilizing the services of both natural and social scientists.

The Canadian government in 1967-68 paid out some $558 million in family allowances in addition to the usual examption of $300 per year of taxable income

for each child. In 1969-70 total costs may not be far from $600 million. It is not strange that this program is coming under examination by the federal government. But the problem cannot be altogether a budgetary one. The fundamental question is whether under contemporary conditions this universal tax-free distribution represents the best structure of expenditures in the interests of Canada's children. If greater benefits can be secured at smaller expenditures, some budgetary advantages may be gained. But in the revision of the program the interests of Canada's children should be advanced rather than diminished.

The creation of an equivalent of the Matador site for the purposes of studying the genotype-environmental reactions of children living under circumstances reasonably advantaged may be left to the scientists, natural and social, who may interest themselves in these projects, either in the laboratory or the "field." What is suggested here is the utility of paralleling basic research which is laboratory-centered (or devoted to finding out in the "field" what the normal paces of child development may be) by applied research projects such as pilot crêches or day nurseries situated in the worst of our urban ghettos, which will take in the children three or four years before they are ready to go into the elementary school system.

The object here would be to create an environment which the slum child, even if only for a few hours a day, could explore with interest and within which he would have the opportunity to grow both physically and mentally at an optimum rate. The immediately scientific aspects of the project would be in the hands of the biologists, psychiatrists, developmental and social psychologists, pediatricians, sociologists and nutritionists who would form the research body. If the constitutional issue should be raised, either as a real issue or as a bogey to serve special interests, it is suggested here that while the federal government

might provide the financing the most effective sponsors might be medical colleges and hospitals attached to provincial universities.

In the Proceedings and printed briefs of this Senate Committee the writer found only one reference to a project of this biological character. The brief of the Federal Department of Agriculture reported "Extensive studies on the importance of genotype-environment interactions on poultry improvement" and added "Our reputation here is international and recognized widely."

The hen, of course, matures and makes her contribution to the GNP within a much shorter period than the human child. But the human child, wholly aside from the other dimensions of his humanity, is undoubtedly the most extraordinary molecular and electronic organism within our own solar system and quite possibly one of the highest forms developed in our own galaxy or others. From the standpoint of pure science, a barren moon is - or ought to be - by comparison a matter of minor interest. Yet in most of the great urban civilizations of the past only a small fraction of their children have ever lived in circumstances permitting them to achieve or even perhaps approach the potentialities they had at birth. We are doing somewhat better now, but globally not by very much.

Decision-making by governments in the human area as in others needs to be backed by basic knowledge and much of this knowledge will be gained by multidisciplinary research and some of this research will be cross-disciplinary research involving both the natural and the social sciences. If decision-making in such areas is to be effective, Science Policy must be formulated and the institutional structure to carry it out so designed that these multidisciplinary projects may be planned, financed, and executed. It may be at times governments themselves which suggest the areas of concern in which basic knowledge is lacking.

Social Science Research Councils and the Social Science Research Council of Canada: There are some ten social science research councils or their equivalents known to the writer. Information from Mr. Elbridge Sibley of the American Social Science Research Council states that he understands that a handbook of these national councils has been in course of preparation by the International Social Science Council and may be about to be published. Their central office is Maison de l'UNESCO, Annexe-6, rue Franklin, Paris XVI^e, France. Meanwhile Dr. Gunther Beijer, Secretary-Treasurer of the Netherlands Council has furnished me with information concerning nine of the ten. The tenth is the Latin-American Social Science Research Council organized in either 1965 or 1966 by a consortium of Latin-American nations. Its head office is in Buenos Aires and it is supported by the Di Tella Foundation. Dr. Beijer lists four (Australia, Canada, the United States and Germany) as being independent bodies under their own authority. Another four, namely those of Finland, Sweden, the United Kingdom, and Norway, are listed as independent bodies under the administrative authority of the government. The Netherlands Council is listed as functionally autonomous, although dependent. As described in my own report, it is a body appointed by the Netherlands Royal Academy. For four, namely Finland, Sweden, the United Kingdom and Norway, all financing comes by direct award from national governments and for Germany principally from this source. For the Netherlands it all comes from the government but through the budget of the Royal Academy. These six include all the known European Councils.

In age, the American Council is the oldest; it was incorporated in December, 1924. The Canadian Council comes next: it was organized in 1940. The third in point of age is the Norwegian. The others were all organized during the 1950's and 1960's.

Through Dr. Beijer's courtesy a great deal of specific information was supplied with respect to the Dutch Council. The staff, for example, in addition to the Chairman and the Secretary-Treasurer is described as follows: "The secretary-treasurer is assisted by two full-time collaborators responsible for compiling the Register of current social scientific research and the work of the Council, one full-time technical assistant, and two full-time secretaries".

The finances of the Social Science Research Council of Canada are much too lean to provide so large a staff. Yet a staff of about this size will be required if the functions listed in my report and approved by the Macdonald Report are to be discharged effectively. Below I set out the revenues of the Administration Fund for 1967 and 1968.

	1968	1967
Administration Charge - Project Grants Fund	$ 8,000	$6,400
Grants for general administration from universities	7,552	2,050
Investment income and interest	11,882	9,368
Royalties	960	792
Totals	$28,394	$18,610

The improvement in financial position in 1968 is owing in part to the fact that some $4,692 of the university grants for 1967 arrived after the end of the financial year and are included in 1968. If this is adjusted the Council is paying about half its annual expenses for administration out of investment income and interest. The administration charge is a fee charged for services in handling project grants and comes mostly from the Canada Council. It has been already noted that all the six European Research Councils listed above get all or most of their financing from their national governments. The writer has no suggestions to offer here and is therefore compelled by circumstances to

leave the problem of effective financing of the Social Science Research Council of Canada upon the doorstep of this Committee.

The chief difference between the present organization of the Social Science Research Council of Canada and that recommended in my report to the SSRCC is the addition of a permanent officer whom I have called the Director. In the American organization the equivalent officer is the President and a scholar of experience and outstanding capacity. The recently appointed President is Dr. Henry W. Riecken, organizer and former head of the Social Sciences Division of the National Science Foundation, Such men require good salaries but it is their qualifications which undoubtedly determine the success of the whole operation of the set of functions set out for the SSRCC in my report. The compilation and continued revision of a register of research projects would also constitute an added expense. It absorbs for example approximately 60% of the expenses connected with the operation of the Netherlands Council.

There appears to be a tendency for Social Science Research Councils to become advisors to governments. My report to the SSRCC named four European Social Science Research Councils which are being called upon for assistance to governments in their processes of decision-making. With respect to the Netherlands Council, information from Dr. Beijer is that this organization takes a form described as "The Government - Social Science Liaison Committee" which "is a permanent committee composed of 18 members, including representatives of most ministries with a social science research division and is headed by the Chairman of the Council."

Relations with government organizations are also being increasingly evolved by the American Council. The headquarters of that Council are in New York City but in 1966 Dr. Riecken left the National Science Foundation to become Vice-President of the American Council in charge of a new office established in

Washington, D.C. This office has been continued since he became President and he now divides his time between the two offices. He has served on ad isory committees of the National Institutes of Health, the National Institute of Mental Health, the Office of Education and of the Secretary of the Department of Health, Education and Welfare.

In addition the American Council "in response to a proposal of the Office of Education has undertaken a survey of area and language problems throughout the country." Another agreement with the same Office has provided for "a series of conferences on research bro dly evaluative of compensatory education programs such as Head Start and Follow Through." (SSRC Annual Report 1967-1968, p. 11).

The amount of money required annually to administer a Social Science Research Council successfully is proportionately a good deal more than the Social Science Research Council of Canada can command at the present time. But the amount required for the most effective operation of such a counc l is a very small percentage indeed of the total research funds being allocated currently to research in the social sciences in Canada. Effectively staffed, organized and financed, the Social Science Research Council of Canada could through co-operation with the professional associations in the social sciences improve the structure of social science research in Canada and provide an organization through which liaisons could be achieved favorable to the planning of multidisciplinary projects requiring the support of disciplines outside the social sciences. As it developed under circumstances more favourable than it has known in the past, it could offer a channel for management of special enquiries requested by the Canadian government or act as advisor to the government on matters concerning the social sciences, location of staff for task forces, and so on.

The Macdonald Report and the Canada Council: With respect to the Macdonald Report, there are two minor and one major problems to be discussed.

The minor ones are as follows: the terms of reference for the Macdonald Studies Group related their enquiry strictly to research carried on in universities. It has been the experience of the writer that there are here and there in Canada what the late Professor J. B. Brebner called "lay scholars." Some flexibility, it would seem, would be desirable for any body supporting research in the humanities or the social sciences to allow for research support here where the nature of the projects and the capacity of the scholar fulfilled the qualifications generally required of scholars working directly with universities. In the second instance, it has been the experience of the writer also that most or even all the research work of university personnel in a good many instances may be done off campus during the summer months. This is rather frequently the experience where the scholar must work with sources not available at home or even very near home. A query appears appropriate here as to whether under such conditions the grants of 35% of the stipend to the university itself is always warranted.

Discussion of the major problem follows. Where my own report recommended that the Canada Council should be split into two Councils, the Macdonald Report recommended that the mandate of the Canada Council to support research in the area of the social sciences and humanities should be terminated and a new Council should be set up to take over this support. I am not presenting any arguments here in favour of one policy or the other as such. I wish only in the first instance to point out the existence of certain fears among Canadian social scientists and humanists - perhaps more acute among the latter - respecting this policy recommendation of the Macdonald Report. There is a fear that there would be a fairly long period of time before an Act could be passed and a new Council organized and that during the interval the Canada Council would be crippled in its operations and that the research interests of the social sciences and the humanities would be jeopardized. Whether these fears are valid I do not know

but I do know that they are real, so very real that there are among these groups those who would be willing to sacrifice expectations of increased opportunity in the future for a feeling of greater security in the present. In view of the fact that anything like significant support for research in these areas dates back only a little over four years, fear may be understandable.

Although the portion of my own report called "Retrospect" was the last portion written and was completed during the winter of 1967-68, it did not deal with policies of the Canada Council in the period following March, 1965, in more than general terms emphasizing the differences in the situation. This policy was followed because perusal of the succeeding reports of the Canada Council showed a condition so fluid that no assessment appeared possible. Great improvements were made but the writer clings strongly to the position that the type of representation in the Council itself as it is presently constituted is not likely to make it a fully effective instrument for the types of tasks and relationships likely to be necessary in the fairly near future (if not immediately) in the area of the social sciences at least.

Biographies of twenty members of the Council shown on pages 30 to 38 of the Canada Council's Brief of April 24th presented to this Committee show the following structure. Of the 20 persons whose biographies are given, there are among the social scientists the following disciplines represented: 1 political scientist; 1 economist; 1 sociologist; 1 general social scientist with a background in Agronomy; and 3 lawyers. For the humanities, there are 1 classicist; 1 specialist in French and the fine arts; and 1 English specialist. There are no representatives in history, anthropology, geography, philosophy, other languages; or in the risingly important area studies related to many regions of the world. Since the political scientist is one of Canada's most eminent scholars in the field of jurisprudence, this means that 20% of the listed Council members are made up of persons with backgrounds in the law. Yet it is only recently that social science studies in the field of jurisprudence have

come to receive any marked amount of attention in most of our Canadian law schools, or in our departments of sociology, a common place to encounter them in other countries.

The Academic Panel has better balanced representation, but here also representatives from anthropology, geography, area studies, and language disciplines such as the Slavic languages are also absent.

The structure of the Canada Council by contrast with that of the National Research Council, in itself makes an invidious distinction between the social sciences and the natural and engineering sciences. The writer recalls with great clarity the hopefulness which arose among scholars in these long-starved disciplines when the Canada Council Act was passed and with even greater clarity the shock, bewilderment, and disappointment at her own university from its President down when the personnel of the first Canada Council was announced. That the addition of the Academic Panel and the great increases in available funds have resulted in great improvements in research support in the social sciences goes without saying. But in structure the Canada Council is still badly balanced in comparison with the National Research Council. The differ ces between the special qualifications required for appointment to the NRC and those required for appointment to the Canada Council carry an implication that scholars in the natural sciences have objective attitudes toward their scholarly research but that those in the social sciences and the humanities require chaperons to ensure their good behaviour.

In another sense, the individual members of the Canada Council are placed in an invidious position also when they have to vote on matters on which they lack the qualifications for judgment. If the Council were to be divided, or alternatively a new Council for the Social Sciences and Humanities set up, the balance of expertise could be very much improved.

From Appendix C, Chart 1, p. 40, of the Canada Council Brief presented on April 24, 1969, it will be noted that the Social Sciences and Humanities Division of the Canada Council has power to approve grants of $5,000 or less and the Academic Panel power to approve grants of $10,000 or less. While these approvals undoubtedly require confirmation by the Council, both experience in other organizations and the peculiar organization of the Canada Council suggest that almost without exception such confirmations are likely to be automatic. It is in the area of research projects requiring financing in excess of $10,000 that the Canada Council appears most likely to exercise its greatest influence and this is the area in which expertise is a matter of the greatest importance.

The type of Council most able to exercise the greatest expertise would resemble that of the NRC. That is to say, while its members in the majority would be drawn from university faculties, it would also contain members of the public with backgrounds of education and reputation in disciplines whose research support was afforded by the Council. In the social sciences at least, there are numbers of persons in Canada in social agencies; banks and other corporate organizations, both financial and industrial; labour unions; and consumer organizations, who have both strong academic backgrounds and strong scholarly interests.

It has been taken for granted throughout that research projects emanating from individual universities would be dealt with by a Council of the Humanities and the Social Sciences without reference to the SSRCC. But there would be three types of research enterprises where the SSRCC would have planning functions to perform. That is to say, (1) they might be unidisciplinary but require co-operation among research scholars from more than one university campus; (2) they might be multidisciplinary among research scholars from more than one social science under the same conditions; and (3) they might be both multidisciplinary

and cross-disciplinary in the sense that successful pursuit of the project required contributions from both the social and the natural sciences.

With reference to (1) and (2) the necessary relationships between the SSRCC and the government granting organization for effective execution of well-planned research projects emanating from the SSRCC are discussed in my part of the Report on the Social Sciences in Canada. Page 89, points 6 and 7, and pages 117-18 give the background for the relationship required. The writer is firmly of the opinion here respecting larger projects that the government organization affording the finance for such purposes should be headed by a board whose expertise matches fully that of the National Research Council of Canada.

For (3) it is a matter of even greater importance that the governing body of this organization should be made up of individuals who are as competent in their own fields as are the scholars who form the personnel of the other government Councils, since negotiations among these would be required in the field of cross-disciplinary research.

The long period of deprivation of research support has had effects upon the development of the social sciences in Canada and to some degree also upon the morale of scholars working in these disciplines. These effects have also been to some degree compounded by a long-held public attitude toward the social sciences which identifies any crank, crack-pot, or opinion-merchant as a social scientist, or more frequently perhaps as an economist, who may be writing in the fields in which the social sciences operate. The writer recalls, for example, the many years over which the late Major Douglas was consistently called an "economist" in the public press.

The humanists must speak for themselves. But if attitudes of mutual respect are to be achieved between the social sciences and the other sciences as the necessary bases for effective co-operation in the search for knowledge, it is a matter of the utmost importance that over the initial period of co-

operation in particular the ablest, most creative, and wisest social scientists in Canada should be the ones appointed to the governing board of the organization which is the controlling body and the source of government grants in the social sciences in Canada.

A large part of this brief has been concerned with multidisciplinary research and in particular with that of a cross-disciplinary nature between the life and the social sciences. This emphasis results in part because the main report emphasized other aspects of research co-operation, and in part because of developments in this area of research enterprises over the past two years. Projects to be undertaken in this cross-disciplinary area may not be very numerous, but their potentials for additions to knowledge in both basic and applied fields related to the national interest could easily be enormous and of the very greatest importance to the decision-making processes of government.

APPENDIX 181

ECONOMIC RESEARCH POLICY.

SUBMISSION TO THE SENATE COMMITTEE ON SCIENCE POLICY

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SUMMARY

This submission calls for rationalization of arrangements for economic research undertaken by or supported by the federal government.

To this end, it is recommended that government:

(i) Appoint a "research adviser and coordinator" to achieve greater effectiveness in the research operations within government, and through commissions, task forces, and contracts performed for government. It is expected that both more useful research and substantial financial economies could be achieved through avoidance of overlap, more careful definition of terms of reference, and better incentives to government researchers through more enlightened publication policy.

(ii) Increase support for individually selected research outside the government and especially adopt the stipend basis as essential to encouragement of research in fields in which competing opportunities reduce the scope and attractiveness of such research activity. This recommendation applies particularly to Canada Council grants.

(iii) Support the establishment of a private research institution in which the performance of sound research is the top priority. Such an organization would encourage interest in and support for economic research in the private community and would bring into being an institution which could effectively undertake public contracts. Its main advantages would include its capacity to seek out qualified personnel from the universities and elsewhere and to organize projects involving substantial resources and complex structure.

The rationalization of economic research services implicit in these recommendations could greatly increase the effectiveness of resources allocated to economic research in Canada.

ECONOMIC RESEARCH POLICY:

SUBMISSION TO THE SENATE COMMITTEE ON SCIENCE POLICY

1 In recent years there has been considerable concern about policies affecting research in the social sciences in Canada. The amount of private financial and other resources allocated to the natural sciences may have warranted the proportionately much greater attention that has been devoted to forms of public subsidy and incentive directed to improving the quantity and quality of basic and applied research and development. But it would be surprising if the returns to appropriate investment in "R and D" in the social sciences would be any less than that generated by natural science studies. Furthermore, it is evident that studies in the natural and social sciences are often complementary. Issues which the Science Council has identified as deserving public policy attention illustrate this very well. Satellite communications become a means of ensuring a measure of national autonomy. The wise use of water resources depends upon judgments about future demand extending from the assessment of the relative merits of alternative energy sources to an examination of the contribution of water-based recreational facilities to the expected age of leisure. The analysis of urban problems commands the attention of every natural science, including applications in architecture and transport engineering, and the full range of social sciences, together with their application to housing, health services, and education. These few illustrations suggest, among other things, that it is likely to be both unwise and, in at least some instances, impractical to segregate the disciplines, particularly where the solution of social problems is the ultimate purpose of the research policies.

At the same time, this should not be interpreted as signifying a common or parallel course for all branches of scientific activity or for the policy designed to foster it. There are certain distinguishing features of the social sciences which affect significantly the appropriateness of the various methods of supporting research in these areas.

1. In the first place, the social sciences are social -- they concern the social consequences of nature and man. Hence, the problems studied are not likely to be sufficiently specific that a particular private firm would be likely to engage in such research under its own roof. An exception would be a regulated public utility. In most instances, the research would be undertaken by government, by a private institution receiving the pooled support of many individuals or enterprises, or by academics in universities if the minimum scale requirement for the project is not too great. Thus, the relative importance of industrial research and development is bound to be much greater for the natural sciences.
2. Secondly, social research is more politically sensitive. In some highly developed societies it is still a rarity for academics to challenge the system head-on with social criticism. Expectations for advancement call for careful avoidance of such challenges; even advancement within academic institutions may depend upon such caution. These same societies have distinguished themselves in work in the natural and applied sciences. In Canada, most people would take pride in the absence of such constraints, but techniques of exclusion can be subtle, and a society that is anxious to preserve its reputation

for freedom and equal opportunity should not neglect the nourishment of institutions that contribute to a balanced output of critical social analysis. This confronts government with a dilemma: being the institution with the primary responsibility for social policy as well as resources for research, it is tempted to keep within its control a large share of such research activity. Even assuming the best intentions, the encouragement of outside agencies capable of mounting an extensive program of critical analysis is likely to receive low priority. This problem is not easy to resolve in countries of limited size unless a wealthy family or foundation is willing to undertake the initial endowment.

3. A third problem besetting the development of social science research relates to the competing demands on social scientists. The nature of their scholarly interest affords them the opportunity, perhaps one should say the temptation, of becoming involved in social policy formulation and administration as well as a wide variety of commission and consulting activity. These latter are often helpful to the development of the scholar and to the relevance of the problems he undertakes to study, and this often makes it more difficult for the individual scoial scientist to pursue a study program purely of his own choosing. Agencies designed to support such projects must recognize that stipends may be essential to the support of individual scholarly research in the social sciences, particularly in the area of so-called "pure" theory.

3 The remainder of the submission will concentrate upon economic research and upon the implications of the foregoing characteristics

of such research both for the present pattern of research support and organization in Canada. Many but not all of the comments and suggestions that follow will be relevant to the other social sciences. In general, economics differs from the others in the more quantitative nature of research activity in this field and the wider use of economists (well over half of the current output of social scientists). This means that some of the problems of economics are more nearly similar to those of the natural sciences and that economists are also more often drawn off into activity other than research.

The Government Contribution to Economic Research

4 Governments in Canada have contributed to economic research primarily through:

a) the research divisions of government departments and agencies, such as the Economic Council;

b) the appointment and support of royal commissions and task forces;

c) Canada Council grants.

One might add a fourth category -- contract research -- except that this is really a method employed by the first two types of sponsor.

5 The basic problem of government departmental research is that it is necessarily restricted in several ways.

i) The needs of all government bodies to retain control over the publication of research results because of the political consequences of free publication and also because of the confidentiality of some data sources used by government.

ii) The priority necessarily given to ad hoc research on current government policy problems, which means that studies requiring

a longer-term approach and a substantial time for adequate quantitative analysis are rarely possible.

iii) The related problem that key research personnel, particularly those who have shown capacity for analyzing and resolving ad hoc policy problems, are attracted into administrative positions in government. For this reason, it has been particularly difficult for the heavily policy-oriented departments to develop and maintain strong research staffs, and the more successful research operations within government departments have depended heavily upon the devotion of a few individuals to the aims of research and their willingness to concentrate upon a research career.

Some of these problems are reduced in government agencies, crown corporations such as the Bank of Canada, the Central Mortgage and Housing Corporation, and the Economic Council of Canada. Until very recently, the Bank of Canada has published almost nothing apart from statistical summaries. The principal contribution of the CMHC has been in the support of university and other outside research programs in housing and related urban problems. The Economic Council has also supported considerable outside research and itself published a number of studies. The degree of independence from government which the Economic Council enjoys has probably helped it to avoid the first problem mentioned above. Its terms of reference have directly contributed to the concentration on analyses of medium- and longer-term factors. But the Council has limitations of its own. These are partly the consequence of its unique character -- a body representative of the principal regional and

functional economic interests aiming to achieve a consensus on economic and social policy questions and to raise the level of public understanding of these issues. A sound input of research findings is essential to the continued success of such an effort, but there is considerable doubt as to whether this research can be best done under the Council's own auspices. The main problem is somewhat analagous to that of the government departments themselves -- some of the most talented people in the Council staff must devote their primary attention to the preparation of the annual review. It might be possible for the Council to achieve more effective research performance as well as to perform its present unique functions, but the real question is whether some other institution might be better suited to the research function. The Council itself has recognized this problem explicitly in calling for the establishment of another institution to analyze current economic conditions and the short-term outlook -- matters that can evoke explosive political issues. But more of this later.

7 The second broad category of government-supported economic research is that carried on under royal commissions and task forces. The time-honoured British institution -- the royal commission -- clearly has a role to play, but there is now a developing consensus that its role has been undesirably broadened. One sometimes gets the impression that each minister wants a royal commissioner over his mantelpiece, properly stuffed. The original purpose of such commissions was to investigate particular issues on which it was vital to have an independent assessment of the facts, and in some cases of the opinions of private individuals and groups. If the issue is highly particular in the sense

that is unlikely to recur in anything resembling the same form, then the royal commission may still be the best vehicle, and a relatively inexpensive inquiry can be conducted. But there is serious doubt about the appropriateness of this same vehicle when applied to such broad questions as Canada's economic prospects, banking, taxation, bilingualism and biculturalism, or the status of women. There may be some justification for a once-in-a-generation examination of some of these questions, particularly if the issues relate to structure questions which are likely to cause continuing problems if not exposed and attacked through public policy. Rigidities or obsolescence in the banking and tax systems provide good examples of the sort of problem. But is the royal commission the best vehicle for such an enquiry? Perhaps the most striking example of a contrast in effectiveness of research may be drawn between the substantial output of the Royal Commission on Canada's Economic Prospects and the single book by Richard E. Caves and Richard Holton on "The Canadian Economy," which was the consequence of an independent study financed by the Canadian Pacific Railway and published by the Harvard University Press at about the time the studies and report of the Royal Commission on Canada's Economic Prospects were being released. The cost of the Caves and Holton study could have been only a tiny fraction of that of the Royal Commission. Yet chapter for chapter, the Caves Holton study is very much more valuable than the output of the Commission, though one should add that any once-in-a-generation study on the long-range outlook is of very doubtful value. Outlook analysis that is not continuously updated is of very limited usefulness.

8 In an effort to reduce the cost associated with royal commissions while achieving a comparable research output, the government has in recent years turned to the "task force" -- a group largely made up of experts actually engaged in preparing papers or studies. This technique has been used rather flexibly: in one case with a minister as chairman -- the housing task force; in another working closely with a group of senior officials -- the foreign ownership (or industrial structure) task force; in yet another, a series of hearings more characteristic of the royal commission approach -- again, the housing task force. Clearly, flexibility and economy are important, but they are less important than the terms of reference and staff arrangements that ensure a relevant high-quality policy analysis. The experience with the task forces so far appointed suggests that there are two opposing risks. On the one hand, if the choice of staff is closely controlled by politicians and their immediate advisers, it is less likely that relevant expertise will be obtained. The choice of a research staff should be left to a research director who is carefully chosen on the grounds of his acquaintance with the talents available in the universities and elsewhere in the professional community. On the other hand, the fact that most task forces will be left largely to the control of research directors, there being no representative commission, means that terms of reference need to be carefully drawn up to ensure that the task force does not become yet another pork barrel.

9 Besides these dangers, the task force suffers from some of the same faults as the royal commission -- particularly the lack of continuity and updating in the research findings which emerge. There is still room

for use of this technique, but like the royal commission it should be restricted. Perhaps the royal commission could be reserved for situations where a truly independent view or cross section of views is required on a controversial or complex public issue; while the task force is used as a means of calling upon particular types of expertise in the formulation of policies in which confidentiality is an important factor, either in respect of data sources or to protect the rights of individuals. Unless one of these factors is present, it is difficult to understand why commissions and task forces should be set up. Above all, they should not be used for social or economic analysis where effective policy formulation and modification require continuity in the availability of relevant data and analysis, a criterion that is relevant to the main elements of stabilization and growth policies.

10 The third vehicle of government for the support of research is the Canada Council (and perhaps one should add the Social Science Research Council as a similar kind of institution, though currently with very limited resources). I have little to add to proposals made by many others for the improvement of the system of research support centred in the Canada Council. I am attracted to many of the proposed reforms suggested in the Timlin-Faucher report. However, I would argue, perhaps more strongly than the authors of that report, that the Canada Council is in many ways not a substitute for other forms of research sponsorship. It is ideally suited to the support of individual academic research and travel, especially projects having high content of theoretical

refinement or politically sensitive questions. It is also possible for the Council to support larger programs, but there are a number of real difficulties in developing such programs on the basis of Council grants. Most of these are related to the fact that group grants require administration. As a federal institution, there are limits to its ability to exercise any control over the universities. But more important, it is not in keeping with the Canada Council approach to enforce terms of reference or administrative effectiveness on research programs. Many important studies are unlikely to be sponsored by the Council. This applies particularly to policy studies which government or industry might wish to see undertaken. The combined requirements of independence of scholarship and effective administration suggest the need for a vehicle complementary both to governmental research activity and to individual projects such as those that are the main concern of the Council.

11 Before the end of these comments on government's role in economic research, one overriding consideration requires some attention -- the coordination of research activities. Government departmental economic research activity is spread over many departments and agencies. There is considerable overlap and a great variety among these research divisions. But unlike the statistical services, research services are neither centralized nor effectively coordinated. It is not appropriate or necessary that research services be centralized in the fashion of Dominion Bureau of Statistics. Each department is bound to have its own peculiar requirements which need not be constrained by the approaches of other

departments. But there would be great value in having a "research adviser and coordinator" attached to the office of the Prime Minister and responsible for advising the Cabinet committee on economic policy on the best methods of developing the information base for economic policy and of rationalizing research services in the face of constantly changing needs. The functions of such an office might be outlined as follows:

i) To maintain files indicating the nature and scope of research on economic policy underway in the Canadian federal government and, as far as possible, in universities and other institutions outside the government.

ii) To make recommendations to research directors of individual departments concerning overlaps with other departments and the methods of filling gaps which arise from expanding and changing policy needs. Where a research project to be undertaken within government crosses the boundaries of departmental or agency jurisdictions, to chair an _ad hoc_ coordinating committee.

iii) To advise the Prime Minister and economic committee(s) of Cabinet on the best way of supplying the research input relating to a particular urgent policy issue and of rationalizing the structure of continuing research services. This includes advice as to whether a new activity is required within a government department or agency, whether a contract with a private organization or university would be most economic means of getting needed research done, or whether it would be desirable to establish a task force or royal commission. This last choice would often, of course, depend on political considerations, but the research adviser would at least be able to estimate the relative economic costs of various methods.

iv) To advise the Cabinet on publication policy respecting economic research findings of government agencies. An enlightened publications policy may make a very substantial contribution to the improvement of government research services by increasing opportunities for research personnel to obtain recognition they deserve and thus to reduce the temptation to abandon research for administrative roles or university positions. Of course, constraints arising out of the confidentiality of government data sources and the political sensitivity of some issues may seriously limit the possibilities of such publication. But more effort should certainly be directed toward reducing the historic tendency for overuse of the words "confidential" and "restricted."

12 As it would be essential for the person holding this role of research adviser and coordinator to be familiar with the requirements of research and to be able to deal effectively with those who are engaged in research outside as well as inside the government, it would probably be most desirable that the coordinator not have a close affiliation with any particular department or agency. This post might afford an opportunity for appointment (probably on a three- to five-year basis to gain the advantage of continuity) of a university economist. Canada has fallen well behind other countries in the practice of bringing such people in on term appointments. This would ensure some variety of approach and experience over a period of years, while fostering the independence of the position. It would be essential, of course, to take steps to ensure that it does not become a purely political appointment. If the selection of a university professor to fill the above post were to bias government-sponsored research in the direction of more dependence

on private institutions, it would be a desirable counterbalance to the traditional tendency to enlarge the superstructure of government and to attach expensive research divisions to quasi-public commissions and councils, with a primarily advisory or moral suasion role. More will be said about the complementary organization of private research in the next section.

13 One is tempted to suggest that the office of the research adviser or coordinator be severely limited in staff size and that it be instructed to reduce the total economic research outlays of government by a factor of several times its own budget. This may be impractical; but it is not difficult to contemplate that the effect of the work of such an office could save substantial financial resources for the government while improving both the quality and quantity of research output. One would be most unwise to try to estimate the size of such savings in advance, but the sources are evident -- knowledgeable research management, reduction of unnecessary overlap through coordination of efforts, a more economic approach to the use of outside professional services.

14 One final word: the above proposal has been cast in the form of an economic research coordinator. This reflects the professional background of the author of the submission. There is no reason in principle why the research coordinator should not be charged with a similar role respecting all social policy research and not just that concerned with economic policy. While economic policy research is likely, on the past record, to be a large share of the total, the nature

of the current range of policy issues suggests that other elements of social policy may be more important in the future and that economic and other social research may have to be more closely integrated. Federal-provincial relations, regional development, urban problems, and international relations all present challenges to interdisciplinary research. If the role of the government's research adviser is to be broadened accordingly, this does not change the essential functions of the office, but it does make it substantially more difficult to fill. It might be desirable to have available a group with different disciplinary backgrounds, but each having a demonstrated interest in the complementary disciplines.

Private Economic Research

The length of the foregoing discussion of government-supported economic research does not signify its greater relative importance. Indeed, one of the principal purposes of that discussion has been to emphasize the need for more effective association between the government demand for and the private supply of economic research services. In what follows, the advantages and problems of the private sector will be explored. The main loci of private research are the universities and private research institutions. Less than ten years ago, the private sector was very narrow. University economics departments were small, and there were very few academic economists over thirty-five years of age who by experience and familiarity with the Canadian social scene could provide leadership in the development of research activity. The Canada Council had been established, but with very limited resources intended to serve the arts and humanities as well as the social sciences.

The interest of private business in supporting research was almost non-existent, though certain particular activities revealed a growing private interest in support of research activity. For example, the Private Planning Association of Canada had been established with a comprehensive charter enabling it to sponsor a wide range of economic and social research activities, but at that time its operations were exclusively concerned with Canadian-American economic relations.

16 During the past decade, a remarkable transformation has occurred, largely as a consequence of the growth of the universities. The rapid rise in undergraduate enrolment has required the expansion of faculties at a great rate, so that there are now two to three times the number of professors there were in 1959, even at the larger Canadian universities, and economics departments at the newer universities have grown at much more rapid rates. (Carleton University, for example, had four economics professors in 1959, whereas it now has five times that number.) Furthermore, the coming of the computer and of advances in the techniques of applied economic analysis have increased the ability of Canadian university economists to analyze empirical questions involving heavy inputs of quantitative data. On the other hand, it must be acknowledged that Canadian universities have not yet developed their graduate instruction facilities in the social sciences. Up until the last two years, Canadian graduate schools made almost no net contribution to the growth in numbers of social scientists employed in Canadian universities and elsewhere. Canadians returning from foreign graduate schools and immigrant professionals will understandably have to become familiar with the Canadian social scene before they are able or willing to undertake research on Canadian problems. The current expansion of graduate facilities should thus

make a more direct and immediate contribution to Canadian applied and policy studies.

17 These developments indicate that in the future it may not be the shortage of skilled professionals which is the primary constraint on economic research it has been during the past decade. The availability of financial resources and the effective organization of research may henceforth be the main issues.

18 Clearly, individual research at the universities will continue to be essential, both because it is fundamental to the advanced levels of university instruction and because there is no other place where the refinement of pure theory and method will receive comparable priority. Furthermore, the right of free criticism of public policy is also exercised most easily and effectively in the university environment. This means that the kind of support which the Canada Council, and conceivably a refurbished Social Science Research Council, can provide must be expanded at least in step with the growth of the size of Canadian university faculties. Further, the level and nature of support must be such as to make truly independent research competitive with research opportunities supported by government. It is a simple economic fact that the social scientists can find a market for their services and can often pursue sponsored studies under terms of reference which offer genuine research opportunities, including right to publication. A stipend basis, albeit at somewhat lower levels than those offered in the private market, becomes essential to the support at least of those kinds of analyses that are unlikely to attract no-strings-attached funds from government and private industry.

19 The greatest gap of all in Canadian economic and social research lies, however, in another direction -- the total absence of a private research institution with sufficient financial capacity to deal with a substantial range of economic or social policy issues. Every other western country of comparable size and wealth to Canada, and many that are less well off, has one or several privately-managed institutions. In the United States there are many -- the Brookings Institution, the National Bureau for Economic Research, and the National Planning Association being three which focus particularly on applied economic questions. These institutions are privately endowed, but they also depend upon government contracts for a very substantial share of their resources. They have demonstrated that the privately-run institution which depends for its continuing reputation upon sound research performance and effective research management is likely to be a good place for the government to obtain research services, whether this involves tapping the ongoing work of the institution in question (as in their econometric model building activities), the support of a program of studies leading to publication, or special confidential analyses (e.g., of the effects of disarmament). A similar role is played by the National Institute of Economic and Social Research in Britain. Best known for its quarterly review, in which it presents and updates its assessment of current economic conditions in Britain and the world and the short-term outlook, the Institute is in some respects a model of the greatest relevance for Canada. It is supported by private subscribers to the Review, by business contributions, and by government grants, which support the kind of studies of basic economic issues that are important in themselves but also ensure a fuller

and longer perspective on the factors involved in analysis of current economic conditions; for example, the Institute's programs of studies on housing and on technology. In still smaller countries, such as Sweden and the Netherlands, the national institutes are entirely publicly financed but are privately managed, and their main work is carried on by economists who move in and out of the institutes, either from academic or government backgrounds.

The great advantages of all such organizations lie in their developed capacity to organize effective research activity, a consequence essentially of their specialized purpose, and their independence both from the sensitivity of government and quasi-government agencies, and from the competition that can develop among universities if they are to be relied on directly for all research services. The privately controlled institution is also able to attract funds from private industry and foundations that may wish to avoid the problem of selecting university recipients and may have more confidence in the capacity of the specialized research institutes to handle their contributions or contracts effectively. The foregoing may be particularly important in those kinds of research programs that involve very substantial sums of money, such as large-scale quantitative analyses or comprehensive analyses of a public policy issue. The main point is thus that the operations of private economic research institutions have in other countries proven to be highly complementary to the work of the universities and of government, and that therefore the lack of any such institution in Canada constitutes a serious gap in Canadian research facilities.

21 It is perhaps useful to comment briefly on the apparent reasons for the failure to date to fill this gap in Canada. Private sources have in the past been both limited and not especially interested in applied social research. There have been few great fortunes in Canada, and those that have provided the basis for establishment of private foundations have mainly supported educational and welfare institutions. One of the reasons that undoubtedly supports this tendency is the geographic dispersion of the country and the feeling of those who command wealth that their first responsibility in philanthropy lies in their own local or regional community. In any case, even if this were not so, it would be most unusual if a specialized social research institution were to be purely privately financed in a country of Canada's size. I know of no such situation in any of the world's smaller nations. It appears that the most likely form of private support that institutes will be able to call on will be contributory support from industry, perhaps also from labour unions, and relatively modest grants from Canadian foundations.

22 The key question that remains is whether and how government might assist in bringing an independent Canadian economic and social research institution into being. It is difficult to understand why the government has not to date made such a move. Until the late 1950s it has tended to rely upon the royal commission, more recently the task force, as a vehicle for the outside policy research it required for its own purposes. Only in relatively recent times has the conviction grown that there were substantial advantages in a continuing research institution in which a reliable quality of research and of research

direction might be built up. Presumably the conviction could only gain ground when there was also some reason for confidence that such an institution could be manned. Given the shortage of professional economists already mentioned, it is understandable that government was sceptical about the prospect for staffing an institute, except perhaps at the expense of depriving government of some of its ablest professional people. During the past decade these attitudes have been changing, however. The report of the Glassco Commission pointed out the usefulness of private research institutes in the United States and concluded that "consideration should be given to the development of an independent economic research foundation in Canada." The report was issued in late 1962, at the time the Economic Council of Canada in its earlier form as proposed by the Diefenbaker government was under consideration. The Council, established in 1963, was considered by many to fill the major gap in economic research facilities. There can be little doubt that the Council has contributed much to the sophistication of public understanding and discussion of economic policy questions and has challenged the government to make sound policy choices. But it has become clear in the past two years that the Economic Council should not be expected to meet all the needs for applied and policy analysis. There are several reasons for this. First, the terms of reference governing the Council's work require it to concentrate upon intermediate and long-term research issues. The Council itself has recognized this in proposing in its Third Annual Review that another institution is required. It is emphasized in the proposal that analysis of current economic conditions and the short-term outlook may have very direct implications

for the government's current monetary and fiscal policies and a high degree of political sensitivity may therefore be involved. For this reason, it is of great importance that the institution responsible for current economic analysis be privately controlled, whatever may be the government's financial role in its support. This is the case in the National Institute in London.

23 A second reason why the Council should not be expected to serve all purposes in policy research is that it is first and foremost a body for arriving at policy consensus. As suggested in the early part of this submission, this imposes constraints on the nature of its research activity. Some people have suggested that indeed the Council should de-emphasize research. The most important point, however, is that at least one institution would seem to be required which places the research aim as its top priority, without modification by the requirement either of political consensus or of that among private groups.

24 There is a danger that in the developments of recent months, this point will again be neglected in the enthusiasm of government for establishing new public institutions.

25 An example may be found in the new proposal for a Price and Incomes Commission. Here again the government is proposing to establish a body which is both a policy advisory group and a sponsor of research. It is not really relevant here to comment on the merits of the Commission itself. It is apparently intended to exercise moral suasion on private groups and on the government with a view to encouraging such things as wage and price restraint and self restraint in government spending.

However effective such a body might be, the serious criticism which is warranted is the danger of duplication of research activity and inappropriateness of such a Commission as a sponsor of analysis of current economic conditions. The White Paper on Policies for Price Stability cites the above-mentioned Economic Council recommendation that "steps should be taken to establish an independent institute of economic research," and cites this as an indication of support for the Commission. What the Council had in mind, however, was the establishment of a privately controlled institute to examine all current economic conditions, not just prices and incomes.

26 It is not clear that the White Paper intends to go this far -- into an institution which would have to examine the current state and prospects for the main expenditure categories -- consumption, private and public investment, government expenditure and revenue, exports and imports, as well as the special problems related to price and income changes themselves. The main message of the White Paper suggests a prior concern for the study of rigidities in the economy, which most economists recognize as more explicitly relevant to the problem of trade-off between the level of unemployment and rate of price increase. The Economic Council conception of the main function of the institute it proposed does not focus primarily on these rigidity questions. If a single body is to be set up to do both, it would be most misleading to tie it to a Price and Incomes Commission, and if the research function is in fact to be narrower, it would seem to involve wasteful duplication of the research effort proposed for any private institution engaged in the full range of current economic conditions. The research aspects

of the proposed Price and Incomes Commission therefore represent either a duplication with work on productivity and structural problems, some of which might better be analyzed under existing government research divisions that already have experience with labour and product market problems, or a second best and partial way of approaching the analysis of current economic conditions.

27 If the government wants a Price and Incomes Commission to give independent advice on these matters, it would surely be better for it to operate in a context where a truly independent agency was making available for public discussion a comprehensive analysis of all current economic conditions listed above, and not just price and income phenomena.

28 This illustration has been developed at some length to illustrate the danger of developing research policy piecemeal. The government itself has hinted at a much broader approach with the Throne Speech reference to comprehensive institutions for the study of government problems. It is difficult as yet to identify the scope intended by that proposal, and a one-man task force is currently engaged in the definitional task. But the main conclusion which is relevant to all these current proposals is that it is time for the government to provide whatever support is required to bring into being a truly independent, privately-managed research institute comparable to those which already exist in other countries. In the light of all the foregoing, there would seem to be reason for placing a higher priority upon such a proposal than upon any further innovation in federal government economic or social research agencies. There is at least one proposal before the government for the allocation of substantial private resources to this purpose; the government

is being asked to match these resources and thus to economize its own resources and encourage the kind of private participation that is in line with its expressed political principles.

29 The main purpose of this present submission is not to focus on the proposal brought to the federal government by representatives of the Private Planning Association of Canada. But certain of its characteristics are illustrative of the opportunities that this kind of proposal opens up. The work of the PPAC to date has concentrated on study of Canada's international trade and investment problems. These studies have been conducted in part under the auspices of committees of private business, labour, and professional people (the Canadian Trade Committee and the Canadian-American Committee) whose members have thus become more actively engaged in the discussion of related policy issues and, it should be added, more interested in supporting the analysis of such issues. Other studies sponsored by the Association have received assistance from a foundation grant and have been organized under a Research Director operating independently of the committees. What the Association is now proposing to do is to join with other private groups in sponsoring a new institution for the support of a wider range of research into applied economic questions, an extension of scope which is, incidentally, permitted by the terms of the present Charter of the PPAC. The new proposal concentrates upon the analysis of current economic conditions, including the short-term outlook. This priority is not adopted so as in any way to preclude a wider range of more fundamental studies, but rather in recognition that in a number of ways in-depth analysis of current economic conditions can be a sound foundation or cornerstone of a private research institution. Among the reasons for this are the following:

1. The analysis of current economic conditions requires specialized expertise on hand to examine on a continuing basis consumption, expenditure, private investment activity, government spending and revenue gathering, and international trade. Familiarity with labour and capital markets could also be important. A substantial permanent staff is thus required and would be available to engage, as time permitted, in fundamental studies (or at least to advise on the need for sponsoring of such studies) in order to widen and deepen the basis for the short-term analysis.
2. The value of a quarterly to report on and update current outlook analysis would also provide a vehicle for publication of the results of the long-term or structural analyses and perhaps also of individual policy commentary based upon such studies. The National Institute Economic Review in Britain includes such articles as a prominent feature of three of its four quarterly reviews, the fourth being devoted to a full report on the annual outlook.
3. Clearly, the demand for a systematic analysis of the one- to three-year outlook for the economy would also command the practical support both of business and of economic policy makers in government, who can benefit from more informed bases for decision making. Hence quite large financial resources are likely to be forthcoming for a private research institution that includes analysis of current economic conditions.

In spite of the foregoing, it should be stressed that a private research institution that concentrated exclusively upon the current conditions would run the risk of imbalance and a loss of perspective

and shallowness of roots. From the earliest stages, both the current analysis and the institution which sponsored it would benefit from a staff mix that would reflect both the academic interest in long term context and the willingness and ability to deal with immediate practical dimensions that concern those responsible for economic policy choices in business and government. In a privately-managed research institution, there may be a better opportunity to bring together on a continuing basis professional research personnel from both government and academic backgrounds. Its principal attraction would arise from placing top priority upon research. Its reputation would depend on the quality of its studies. This is not characteristically true of any government agency which sponsors research as a subsidiary purpose, and all existing government agencies are of this sort. Those who come to work in such an institution from government backgrounds will be those who find a research career most attractive, and not a stepping stone to administrative positions. Those who come from universities will typically wish to gain the advantage of a period of concentrated applied research activity under conditions of minimum restriction on research and publication. It would be important that professional research personnel, and particularly those familiar with the requirements of academic freedom, should play an active role in the board of directors of the private institution charged with the ultimate financial control of the organization and the broad terms of reference within which its executive director would operate.

31. It should be added that certain issues can probably be studied with much less constraint by a private institution than by one sponsored by any particular government. These would clearly include federal-

provincial economic relations. Any research organization attached to a federal government is constrained in the scope of its research and publication activity in this field, and its claims to objectivity may be challenged.

32. From a government's point of view, the ultimate danger in helping to finance a private policy research organization lies in the right of free criticism which any such body must retain. This does not, of course, include the right to lobby or indeed to take a political position as an institution. These are not the appropriate functions of a research body. It does mean that through the publication activities of such an institution, individual scholars may express critical views on policy matters. In such institutions in all democratic countries, government provides resources for the support of activities that will make possible an increased flow of information about social policy and hence more possibility of public policy criticism, albeit better-informed criticism. The proposal that government undertake to match private support in order to bring into being such an institution in Canada is put forward with confidence that Canadian governments have no more to fear from informed criticism than other governments which have followed the same course.

APPENDIX 182

BRIEF SUBMITTED TO

THE SENATE SPECIAL COMMITTEE ON

SCIENCE POLICY

BY

DR. JULIUS LUKASIEWICZ

Brief
to the Special Committee on Science Policy
of the Senate of Canada
Submitted in June, 1969

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Content

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1. Introduction

The purpose of this brief is to draw attention to some fundamental aspects of science, research and development activities in Canada which are perhaps more clearly visible from the perspective of one who has had the experience of working in England, Canada and the United States and who, over the past ten years, while living in the United States, has closely followed the Canadian scene. From such a perspective, the technological unity of the North American continent and the internationalism of science and technology become very evident and relevant to the situation in Canada.

2. Major Issues

It is suggested that the following issues in the broad area of science policy (as described in the Orders of Reference of the Senate Special Committee) stand out as the most significant:

(i) The consequences of the Canada-U.S. relationship for the Canadian science and technology and development of policies designed to derive benefits for Canada from this unique situation;

(ii) The desirable structure of the Research and Development effort in Canada;

(iii) The desirable fields for Research and Development in Canada;

(iv) The consequences of high technology and the need for sociotechnological policies and controls.

3. Canada as part of the North American System

In discussing the Research and Development situation in Canada, it has been customary to compare the Canadian scene with that in other industrialized countries, such as United States, Sweden, United Kingdom, etc., in terms of such factors as Research and Development effort relative to GNP and to the population, division of Research and Development effort among basic and developmental fields, etc. On the generally accepted assumption that a high level of Research and Development activity is beneficial to socio-economic development, it has been argued that the level in Canada should be increased to the level in the leading countries (i.e., doubled or tripled), by direct government spending and incentives to industry. Although such arguments sound highly plausible and usually pass unchallenged, they fail to stand up on closer scrutiny.

The failure stems mainly from lack of appreciation of the relation of Canada and the United States. Although the two countries are not bound by a formal treaty such as e.g. the six nations of the European Economic Community (Common Market), they are more closely interdependent in the socio-economic sphere than any other two countries in the world, and form one North American System. This, of course, is the natural consequence of geographical proximity and ability of Canada to exchange resources needed by the United States, to the benefit of both countries. The export/import statistics clearly depict this situation: 70% of Canadian imports come from the United States, and 55% of Canadian exports go to the United States; over 22% of United States imports come from Canada (1964 figures).

It is therefore hardly surprising that a large volume of

technological know-how and many fruits of Research and Development are effectively imported by Canada from the United States. Moreover, since the Canadian consumer market represents less than one-tenth of the United States market, on the basis of economic viability the Canadian market is bound to be dominated by the United States designed products and the United States industrial Research and Development effort.

Examination of the GNP per capita and Research and Development expenditures per capita in Canada, United States and other countries (see graph) indicates that, contrary to the popular views, Canada finds itself in a privileged position of having second to the highest (United States) GNP per capita while spending relatively less on Research and Development than the industrialized countries of Western Europe.* In fact, in this graph Canada's position lies on the line of maximum GNP for any given level of Research and Development expenditure (per capita).

This is not due to a particularly high effectiveness of the Canadian Research and Development effort; in fact, the present structure (see p. 7) of the Research and Development effort in Canada is such as to virtually prohibit any significant impact on economy: the effort is research rather than development oriented, and, moreover, most of it is conducted intramurally in government laboratories, in isolation from industry. Irrespective of its objectives, in these circumstances the Canadian Research and Development activity cannot be economically meaningful.

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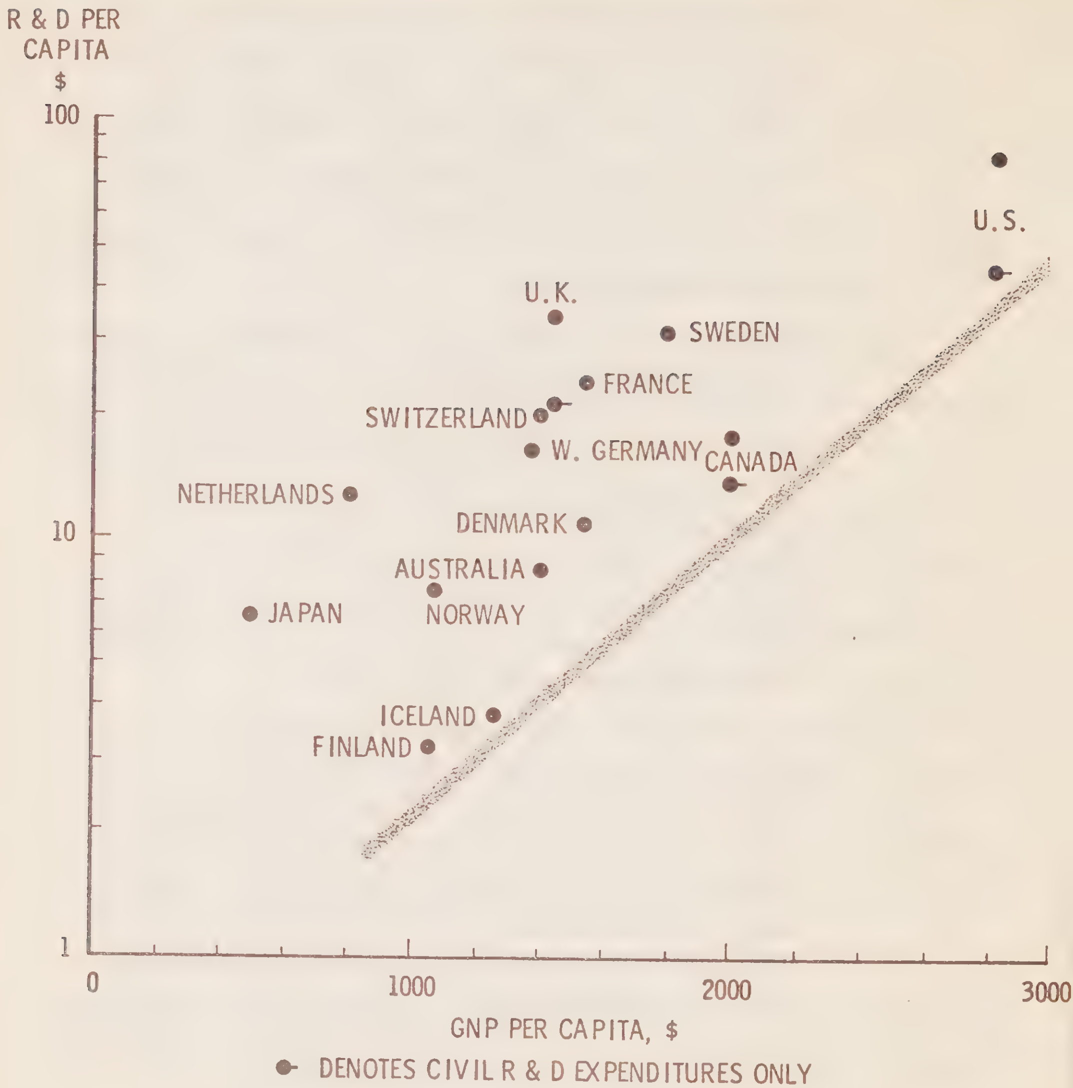
*The same point is illustrated by the newer 1963-64 data for Canada, Sweden and the United States.

	Canada	Sweden	USA
GNP per capita - $	2185	2095	3150
R&D per capita - $	23.5	36.9	105



EXPENDITURES ON R & D VERSUS GNP ON PER CAPITA BASIS (1961)

It is thus evident that Canada, because of its geo-political situation and its resources, has unrestricted access to the most advanced, United States technology, and that Canadian consumer derives all benefits from this technology while paying only a small fraction of the Research and Development costs which are largely absorbed by the huge United States market. Clearly then, a viable Canadian Research and Development policy cannot be based on simple comparisons with other countries, but should result from appraisal of realistic opportunities for Research and Development in Canada, notwithstanding the fact that such approach might be politically displeasing to some groups.

As discussed above, realistic Research and Development opportunities in Canada should be based on a unified view of North American technology, since neither technology nor science respect political boundaries: expansion of international operations of modern corporations in spite of political roadblocks, as witnessed over the past several years, furnishes ample proof of this characteristic of high technology. Moreover, since Canadian consumer market is a small but integral fraction of the North American economy, the opportunities for economically significant and viable Research and Development in Canada lie in specialization within industrial operations of large firms, Canadian-controlled or foreign-controlled. (Incidentally, the same approach is applicable to production operations, as successfully demonstrated in recent years by the Canadian-U.S. automotive industry). This is the way in which Canada, in spite of its small domestic market, can assume full responsibility for large, but specialized operations (Research and Development as well as production) within the North American economy, and, within these specialized fields of activity, can retain top notch talent. Clearly, the above is not an acceptable solution to those

who would like to see the science and technology in Canada as a miniature replica of the situation down South or of the disappearing national economies of some European countries and who oppose "branch economy" as politically undesirable and otherwise unprofitable. And yet, the very nature of modern technology in the service of mass consumer society is such as to render nationalistic and political considerations, as well as productive self-sufficiency, highly invalid. The road to economic profit lies in productive and managerial efficiency operating in a large market; and, provided large volume and high competence are assured through plant specialization, it is inappropriate to attach the stigma of "branch economy" to such specialized operations. Such successful and profitable ventures as the United Aircraft Corporation of Canada well illustrate this point. It is not the geographical location, but the role which the Canadian industry plays within the North American or global economy that determines its contribution to Canada.

4. Structure of Research and Development Effort in Canada

Following the publication of the Glassco Report in 1963 (vol. IV, section 23, "Scientific Research and Development"), the undue emphasis on basic research at the expense of developmental effort, and on performance in government laboratories rather than in industry, have been widely recognized as responsible for economic ineffectiveness of government sponsored scientific and research and development activities in Canada. Typically, these characteristics are illustrated below by comparison with the United States situation.

R&D Structure in U.S. and Canada, 1963-4

	Canada	U.S.A.
Basic Research (% total)	16.1	10.2
Government funded (% total)	62	66
Intramural (% government funded)	78	19
Performed outside of government laboratories (% total)	52	87
Development (% of government funded R&D)	27	69

For the Canadian Research and Development effort to become economically meaningful, these characteristics must be reversed, with emphasis on developmental Research and Development and performance by the private sector.

The situation of basic research in Canada has closely followed the description given by the Unites States National Academy of Sciences: "A position of leadership in basic research might benefit a nation almost exclusively in terms of the intangible prestige of scientific accomplishment, the concrete benefits of the application of scientific findings being reaped mainly by other nations. In that case, the expenditure of public money on the support of basic scientific research would serve mainly to save other countries the cost of basic research and enable them to concentrate on development and application. Thus, the nation that spends a comparatively large amount of public funds, relative to other countries, on establishing scientific leadership is spending its money to a significant extent for the benefit of other countries."

It is suggested that the basic research policy in Canada should have for its objectives to

(i) decrease the support for basic research to a level below 10% of total Research and Development effort, and

(ii) gradually transfer the basic research activities from government laboratories to universities. It is generally accepted that basic research is done most cheaply and effectively at universities, and is then also of educational value. None of these advantages accrue in a government laboratory.

To expand further on the latter objective, it is suggested that consideration should be given to transformation of NRC (and perhaps other government organizations) into a graduate engineering and scientific school to be affiliated with one or more universities. In this way an extremely valuable physical plant would become available not only to education, but would also be used more effectively in research. Such transformation could be implemented gradually, with qualified members of the present staff joining the faculty, and others continuing work on research projects sponsored by the government. Eventually the operation would be like that of a graduate school, the research specifically sponsored by government being performed on government funded projects.*

5. What Research and Development is viable in Canada?

It has already been suggested, that Research and Development in specialized sectors of high technology, as part of the overall North American effort, is the most rational and beneficial approach to be taken in Canada. In addition, the following areas appear to be of particular significance, and could merit public support:

(i) Productivity.

According to the Canadian statistics, the average productivity in Canada is one-third

*Incidentally, as regards NRC's large scale test laboratories, consideration should be given to their operation under contract to a private firm, a flexible method extensively used by the U. S. government.

lower than in the United States. This is exactly the ratio of the GNP per capita in the two countries, and is also reflected in the lower wages in Canada. Although this situation should be recognized as one of the major national problems, it seldom is. It would appear that, although the same technology is available, Canada does not make as good a use of it as does the United States.

There is need for research to determine the causes (technical, managerial, and other) of the lower productivity in Canada, and the remedial actions. Since the bulk of Canada's wealth lies in the natural resources, such as minerals, research directed toward improvement of productivity in the basic industries, and development of new and more efficient, automated process methods, would appear to be particularly worthwhile.

(ii) Education.

It is suggested that industrial Research and Development specialization might be reflected in the support of university research institutes in appropriate areas.

Two other aspects related to education need to be mentioned:

Research into teaching methods and curricula in the face of exponentially increasing volume of knowledge and high degree of its immediacy (or obsolescence).

Research into methods and means of retaining those workers whose jobs have been technologically eliminated, and who are not equipped for higher grade work. One can envisage that all work of a routine, repetitive character will be eventually performed by machines, and that a general upgrading of the skills in demand will result. The lack of work for the nonqualified or the mentally under-equipped might

become a major social problem, and should become the subject of research now.

(iii) Military Research and Development.

This is a politically sensitive topic (The Engineering Institute of Canada in its brief on "A Canadian Policy for Research and Development," submitted to the Minister of Industry in March, 1967, elects not to discuss it, p. 26), but nevertheless should be scrutinized. In view of the size of Canada's territory and the smallness of its population, and its geo-political situation, the use of Canada's voluntary armed forces can be only envisaged as part of an allied force or a UN expeditionary force. In both cases, in view of the size of Canada's contribution, logistics dictates the use of common equipment. In any event, since Canada has access to the United States and the United Kingdom equipment, and since in action Canada would use such equipment, what is to be gained by weapons of original Canadian design? It seems clear that in the military field, the Research and Development should be concerned with applications and field operations (e.g., limited warfare techniques) rather than with development of original equipment (cf. CF 105 fiasco). Here again, Canada is in a privileged position of having its defense virtually assured by the United States -- and it should take advantage of this situation, and devote its resources to the development of civilian economy.

(iv) Products for selective consumption.
High-grade products of original design, such as furniture, chinaware, glass, textiles, etc., which do not fall in the category of mass produced consumer goods, can attain an economically significant volume (Denmark leads here.) It is suggested that activity in this field should be supported and expanded. This is one area in which the proximity of the United States has little relevance, except as convenience of a large potential market.

6. Toward Sociotechnological Policies and Controls

It is suggested that in an advanced, industrialized society the single most important, long-range concern of government should be with the undesirable effects that high technology inevitably brings about. As we shall see, in view of its geographical proximity to the United States, and its political independence, Canada has at least potentially some unique opportunities of guiding its development toward creation of a harmonious environment.

The list of effects of high technology which are detrimental to society and environment as observed in the United States, is an infinitely long one: such phenomena as pollution of all kinds, explosion, destruction and economic decay of the cities under the influence of the automobile, congestion and lack of convenient transportation, abuse of chemical poisons, etc., are now generally recognized. These and others are surely symptoms of the fact that the artificial environment of high technology lacks any built-in mechanism which would assure its stability, and that its rate of growth is so high as to virtually preclude timely adaptation-

characteristics diametrically opposed to that of the natural environment which exhibits a high degree of stability and a slow evolution.

While trying to cope with the artificial environment, we find that its complexity defies our intellectual ability (for example, we are usually unable to predict with any accuracy the social effects of a technological invention, or to make choices on other than an economic basis), and that the system of free market economy, proven most effective in developing the high technology consumer society, is ill suited to deal with the undesirable consequences of high technology. Since these are environmental in character, they cannot be dealt with on the basis of individual, consumer demand. Clearly, to buy clean air or unpolluted rivers, or an efficient mass transit system, a collective political action is required in behalf of the individual members of society. Moreover, to be effective and economical, such action must be taken ahead of the time the need may be generally recognized. These requirements are not compatible with the free market economy, which relies on individual consumer's demand and reflects the situation of today rather than tomorrow. The general plight of the United States cities is a good demonstration of the inadequacy of our present politico-economic system. Indeed, contrary to what is generally considered as desirable economic growth, the necessity of dealing with environmental deterioration can be expected to shift innovation from the consumer market to "preventive" and "corrective" technology. This would in turn tend to slow down the production of consumer goods and increase the services to be paid for by the public; i.e., to arrest the growth or even lower the standard of living.

In view of the above considerations, it would seem that the government representing the collective consumer interests, must assume the role that the individual previously fulfilled in creating the demand in the society of high technology. Indeed, this appears undoubtedly the most important task for which the government should be preparing itself -- and also the most difficult. The new role must involve long-term value judgments of material progress in terms of benefits to society and individuals, and implementation of such judgments by suitable controls and legislation. At present, the government serves to advance purely technological interests since it lacks means to judge their worth and is under the pressure of political opinion which often identifies any technological innovation with "progress."

The democratic representation is entirely non-specialized and political, based on adherence to a political doctrine or a party platform. It does not recognize the fact that sociotechnological interaction has taken over from ideology as a factor which moulds the life of society. Means will have to be found to upgrade the sociotechnological awareness and competence of elected representatives -- an objective that no democracy has yet achieved. The crucial question is how to combine professional competence with the democratic process of government and thus insure adequate controls of technology.

It has been suggested that scientific or technological issues of national importance should be subjected to a judicial process, in which the experts on both sides, i.e., advocates and opponents, can publicly express their opinions. The present practice usually amounts to examination of proposals by committees, selected by

those responsible for the decision, and hence seldom objective. The current ABM (antiballistic missile) debate in the United States has well exposed the inadequacy of this approach.

The above comments are applicable to any highly industrialized society. However, the situation of Canada is unique because Canada can look upon the United States as on a completely accessible, huge socio-technological laboratory, which is always the first to make experiments and produce results--a sociotechnological "early warning" system.

The uniqueness of this situation, which should be vigorously exploited, lies in the complete availability to Canada of the most advanced technology, coupled with independent political controls. Therein is an unusual opportunity for Canada to develop effective and timely sociotechnological policies, and to heed the lessons of the society that is developing in advance of Canada.

There are indications that some small industrialized countries, such as Switzerland and Denmark, have been able to sustain technological change with less social strain than has been evident in the United States; a more harmonious marriage of tradition and technology has been apparently achieved, a goal desirable for all industrialized societies.

We have outlined some of the crucial issues which face the government and the society of high technology, and which are not amenable to effective controls under the present political and economic system.

One of the prerequisites for development of such controls and legislation is acquisition of information and methodology in the broad field of environmental and

social impact of technology. This, indeed, is the area in which truly massive research effort should be supported by every modern government. So far, because of the complexity and the interdisciplinary character of the subject, only sporadic studies have been conducted, and only ad hoc governmental bodies have been appointed to develop recommendations.

There is urgent need to consolidate and expand governmental efforts on the cabinet level by creation of a "department of environmental control" or the equivalent, and to initiate a comprehensive program of research centered, for example, at a number of university research institutes established for this purpose. The priority given to these proposals should reflect their significance as indispensable means of assuring a better future for society.

Moreover, there can be little doubt that Canada will be eventually the main source of natural resources for the North American continent, and therefore long range forecasting, policy planning and controls in the domain of exploitation of natural resources are particularly vital to Canada. Federal and provincial participation in these activities is necessary.

7. Summary and Recommendations

(i) It is evident that Canada, because of its geo-political situation, has unrestricted access to the most advanced, United States technology and that the Canadian consumer benefits from this technology while paying only a small fraction of the Research and Development costs which are largely absorbed by the United States market. In this respect the Canadian situation is unique and its

comparison with that of other small, industrialized countries is not completely relevant.

(ii) Opportunities for economically significant and viable Research and Development in Canada lie in the specialization within international operations of large firms, Canadian or foreign. In this way Canada, in spite of its small domestic market, could assume full responsibility for large operations within the North American and global economy and could attract top notch talent in specialized fields.

(iii) The structure of Canadian Research and Development activity should change the emphasis from basic to developmental effort, and from performance by government to performance by industry. These changes are needed to assure the economic effectiveness of the Research and Development activity.

(iv) In line with (iii) above, consideration should be given to gradual transformation of the NRC (and possibly other similar organizations) into a graduate school of science and engineering affiliated with one or more universities. This would assure educational benefits, effective research and most beneficial utilization of valuable physical plant. As regards NRC's large scale test laboratories, consideration should be given to their operation under contract to a private firm.

(v) Research aimed at increasing productivity in Canada (which lags behind the United States) should receive high priority, whereas military Research and Development should be deemphasized (since equipment of United States and United Kingdom is available to Canada).

(vi) As a matter of highest national priority, science policy should be concerned with the development of political mechanisms, controls and legislation

necessary to prevent the appearance of the detrimental effects of high technology, presently so evident in the United States. With the United States being a completely accessible, huge sociotechnological laboratory, which serves as an "early warning" system, Canada has a unique opportunity to avoid some of the pitfalls and to develop a more desirable environment for its society. A massive effort is required here, and it is suggested that it should be supported by a new, cabinet level "department of environmental control" or the equivalent, and by a major effort at the university research institutes organized for this purpose.

APPENDIX 183

BRIEF SUBMITTED TO

THE SENATE SPECIAL COMMITTEE ON

SCIENCE POLICY

BY

PROFESSOR F.ERIC BURKE

A BRIEF TO THE SPECIAL SENATE COMMITTEE ON SCIENCE POLICY

1. Summary of conclusions, and recommendations

1.1 Political action regarding "Science Policy" will be directed at changes in policies, not their original formulation: we practice a traditional set of science policies now.

1.2 Partly because of the way briefs have been invited for your Committee, and partly because of the pattern of Canadian Life, the evidence you have heard shows selection and bias. This brief is an attempt to add comments from a bias so far poorly represented, rather than to increase the volume of factual information already available to you.

As a student of industrial and governmental research and development, I have been pre-occupied with strategies for obtaining both economically and socially desirable results. This has led me from a research engineering background, and the problems of directing such research and its use, to a very general inquiry into the processes of innovative behaviour. Presently backed generously by the Killam Awards programme of Canada Council, my interests now centre on econometrics, psychology, information flow, and organization, and it is with this transdisciplinary bias that this brief is written.

1.3 "Economically and socially desirable results" is a label for so great a variety of ends that little agreement on means has been reached. For the purpose of this brief I shall concern myself with employment as the main neasure of economically desirable results. When employment is of the quality aimed at in the phrase: "the human use of human beings", it will also be socially desirable.

Employment as a measure is superior to money, and to productivity, when long time spans are considered, and when it is desired to make comparisons with other nations (except the U.S.) where money values and product mixtures are very different from ours.

This manner of assessing results is also preferred to the list given in the"guide to the preparation of briefs", Sect. II.2.8. What has been called "output" there is closely related to scientific work, but must be regarded as intermediate output to the needs of society until the relation of science to society is far better understood than it is at the present time.

1.4 A major change in policy that I would like to urge strongly is in the Canadian pursuit of long-range (20 - 40 years) results, on a more balanced basis than we have done to date. By "long term" I mean a slow process of innovative behaviour* but not:

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* I have chosen the term "innovative behaviour" to show that I cannot use conventional concepts here, such as: research, discovery, invention, innovation, diffusion, adaptation, applied science etc. . There are many kinds of innovative behaviour, and an exhaustive list of definitions would be longer than this brief.

i) "long term" because, in our present circumstances, we may find it difficult to start a process for (say) 20 years, which would take only 5 - 10 years to accomplish once begun - although the total time lapse might appear to fall into my region of concern. An example may be the various forms of pollution, of which we have known both problem and means of attack for some time, but have not found ways of resolving the question who should pay for the costly things we need for them.

ii) "long-term" because of the size or complexity of the undertaking which might be well defined (or definable) at the outset, and yet take 20 - 40 years to complete even if started now. Typically, projects susceptible to systems approaches, as integrated transportation, reshaping of our urban environment etc. would fall under this heading, often called "mission oriented work" recently. These have the important (and in my view necessary) condition that all their elements, as well as the "mission", are or can be well defined early in the project. A number of these, though perhaps too "defensive" a selection, are described

and justified in the Science Council's Report #4.

1.5 In many cases (and probably, even today, the majority of them) such innovative behaviour is <u>not</u> pure or basic science and would <u>not</u> be encouraged in any of the North American institutions conventionally regarded as the sources of long term results (e.g. research labs. and foundations, or Science and Engineering Faculties of Universities). As we become better administrators, the chance is diminishing that this continues to happen accidentally or subversively, yet at an adequate rate. Nor is the "lone inventor" an adequate target for support. Partly, because less than 1/1000 of the patented inventions meet my criteria of "results". (sect. 1.3 above). Partly, because the innovative behaviour I am talking of has become just as expensive as a unit of "small science", i.e. the cost of one fully supported professional at the bench, or $25 - 50,000 per annum for several years. Perhaps the clearest historical example of such behaviour is that of Godowsky and Mannes' development of colour film, through I have found hundreds of other cases of varying clarity.

1.6 It has often been urged, also by the Science Council, that Canada does not need deep concern with long-term work such as I describe, because we can so readily "import technology" from our

great neighbour and elsewhere, and in any case because we can never hope to produce more than about one percent (more or less) of our needs in this area. I believe this conclusion is wholly false. Because held by so many Canadians, it is perhaps the single most important managerial/entrepreneurial defect at the base of our well-recognized industrial shortcomings in the area of science usage.

1.7 The Canadian situation in this respect is much more similar to that of other small nations than we, in our complacency, are ready to admit. In any case it is quite parallel to that of regions within the United States, <u>none</u> of which can be innovatively more self-supporting than we are in Canada. With the single exception of defense (less important here, nor real factors in Japan, Denmark, or Holland either) none of the means of support available to any separate region in the U.S. is beyond our purse. In support, it may be shown that some of these U.S. regions have "science policy" problems at least as serious as our own.

1.8 Particularly striking, and completely at variance with the conventional picture(even condoned by Dr. Saburo Okita who appeared before you on November 27th, 1968) is the <u>practice</u> of "importing technology" of Japan. In a startling paper read in

Cambridge this April, Dr. Keichi Oshima gave more meaningful data on Japanese R & D etc.than we have yet seen (except hidden so well that extensive research was needed to come to the same conclusion earlier). Their "import of technology" is undertaken by the most intensive basic (non-defense) research manpower concentration in the world. It is so actively acquisitive that a third of the imported technology (and the "imports" are about 600 out of 3000 Japanese innovations since W.W.II) was first brought on the market in Japan, rather than the country from which the technology was imported.

1.9 The only positive conclusions regarding such long term, innovative behaviour in Canada are: that we need it, that it needs policy changes (it cannot be left to fend for itself), and that it needs to consist of a large number of small scale efforts diffused through all of Canadian life.

1.10 A General Conclusion: the permanent control of science policies must reach beyond the realm of science in representation. The problems needing selection and support are of such diverse time-scales and unit volumes that no single agency should be charged with this task.

RECOMMENDATIONS:

1.11 Canada needs to encourage long-term innovative behaviour in conjunction with "imported technology", and policy changes to sustain such encouragement by specific granting mechanisms.

1.12 Because of the long term nature of such work, criteria for areas to be encouraged are beyond the time horizon of any present government agency, including the proposed "Technological Forecasting Unit" of the Ministry of Industry, Trade and Commerce.

As such long future perspectives are of necessity transdisciplinary, it is recommended that in addition to any modification of shorter term scientific policies, the strategic selection of areas for the support of innovative behaviour should be made one of the functions of the long-term Research and Thinking Institute now being considered, and reported on, by Mr. R. Ritchie (in regard to Hansard, September 12, 1968, p.8 col.II, par.3).

2. Comments

Introduction: the needs for changes in Science Policies

2.1 It is often said that science policy is a recent matter, and your chairman has been gracious to scientists (appendix 43, p. 4833 #39 of your proceedings) in suggesting that its urgency is largely due to "you researchers making the fatal mistake of become more fertile and more expensive".

I view public policy as "politics made regular", and politics as the art of choosing the best among the options available to the public and its representatives. Thus choices embodied in laws or permanent institutions seem to me to be policy, and the existence of the N.R.C., D.R.B., the Science Council, and of many other established arrangements and their predictable practices constitute the science policies of Canada. Similar evidence of Science Policies is found elsewhere, and I have difficulty in determining their beginnings-surely important and fruitful examples can be cited to go back well over a hundred years.

What, then, are those changes in circumstances that have made science policy so urgent today, and what changes do they imply so that Canada might acquire new policies, and drop old ones, to maximize benefits from science?

2.2 Increase in cost, volume and importance of science are usually accepted as those circumstances that render a review of science policy urgent. I doubt that this is

right. We spend more on roads, or on welfare than on science, and both classes of public expenditure have grown as dramatically as science costs. Yet we have not had years of debate and enquiry about road policy or welfare policy. Perhaps we should.

But I suspect that we seek a "science policy" because there is both magic and unease connected with science but not with roads or with welfare. Also, in the area of science, there is a powerful feeling that perhaps we need to leave scientists alone, or even that we can't do much else anyway because we don't understand them. This is part of the worrying unease.

Now many students of science are beginning to agree on the existence of two circumstances that are increasing the need for science policies more rapidly than does the cost of science. The same students do not agree how these circumstances should be dealt with: so their implications on policy are a matter of debate, but a description of these factors may be helpful.

2.2a) Modern science has no clear starting date, though many fields of Science had become "modern" in 1750. in each field, the change to a modern pattern was a process of self-organization, which incidentally made the "paper" rather than the book the preferred medium of communications with Science, and increasingly just within its branches. This saved the need to re-state

those assumptions, definitions and elementary illustrations with which books on tough subjects start, on the ground "the scientists" know these, and are agreed upon them. Those who did not, either were not scientists at all, or belonged to a different branch of science. The lack of understanding of other scientists of the "home field" would be matched by a home team member's inability to deal with a paper from the "away team's" field; and it is this sharing out of fields for intensive, cumulative and progressive effort which constitutes both modern science and its self-organization. Now since most science became modern in this sense, notably between 1750 and 1950, all inputs to science have grown with a uniform exponential increase-whether the "input" was people, laboratories, papers, journals or what have you. And this rate of growth was very fast, compared to the growth of national wealth, or of populations. The steadiness of the growth rate implies, to most scientists or students of science, the existence of a simple law governing the process of growth. The alternative would require the mutual cancellation of several opposing factors; not only a more difficult pattern conflicting with the law of parsimony (this has, of course, happened before) but unusual in maintaining exact cancellation for 200 years!

But whether a simple law, or a balance of several, in the U.S. in the 1950's the process has changed drastically, and almost certainly similar drastic changes will occur elsewhere (where that has not already happened). To understand what this may mean for science policy, let us look at one of the simplest interpretations of the steady exponential growth law:

i) Each question resolved by an experiment, or the simplification of view contributed by a new theory, gives rise to new experimental and theoretical questions.

ii) The number of new questions so generated, when assessed by the internal critical process of peer judgement, is greater by a constant fraction than the number of answers which provoked them.

The constancy of both provocation and its multiplier on answers regulated science, the critical judgement of peers being demonstrably adequate to prevent cancerous excesses of growth.

This self-regulation of science has been studied and advocated by many, but most articulately by Professor Michael Polanyi. As a result the regular growth law of science seems to have been honoured by his name in Britain recently. Two consequences of this law are: i) justification to leave science alone (i.e. no <u>central</u> science policy institution) and ii) the surprising consequence that until 1950, complaints about

old buildings and apparatus out of wire and sealing wax not withstanding, the growth of science was not seriously hampered by external (e.g. financial) constraints.

But since 1950-1955 (in the U.S.) both cost and manpower inputs to science have progressively fallen short of the constant exponental growth of the Polanyi law, and may have been level in physical terms, since the 1960's.

In consequence, the internal judgements of peer groups can no longer cut science's coat to fit its cloth. For once a project is acceptable in standard of competence and expected contribution, the process of self-regulation of science has done all it can. If further control is needed, it will have to come from a new mechanism: I think this <u>is</u> a new reason for urgency in revising science policy.

2.2b) A second feature of self organized modern science reinforces the need for science policy changes. While the number of scientists has grown exponentically for two hundred years, that number whose papers they "understand" to the extent that makes sense of their self-organization has remained as nearly constant as can be determined. Groups of this type have been given varying names, of which "invisible college" is perhaps the

best known. In 1750 there were perhaps 3, today there are certainly over 1000, and quite possibly as many as 3000 such groups. No single scientist is likely to exhibit anything professional that is more useful than ignorance, outside at most 1% of science.

Thus one of Polanyi's views, that allocation processes can leave science free because of boundary continuities of judgement, must be rejected. To accept rather than reject this view would be the same as to say that all soap films hung on wire have "just the right shape". Now soap does form minimum potential surfaces, but their shape ultimately depends on the shape of the wire. You need a flat loop to get a flat soap film (neglecting wind etc.), and if you want other shapes, other wires. And the continuity laws of soaps films may help to say what shapes you can get at all, but won't tell you what shape you want.

Thus the immense fragmentation of science makes central science policies newly urgent. And I think both the breakdown of self-regulation in the face of limits on inputs, together with the decrease in effective communication within science, imply strongly that the needed changes will have to reach beyond science-while including science representation to the fullest practical extent.

2.3 Science policies and the political process

In 2.1 some remarks were made on the relation of policy (as something regular, or a rule) and the choice between options available to the public and their political representatives. This assumes that options are, in fact,

available for choice. Increasingly in our technological age, this is simply not the case. Either no option is available at all, because it costs a great deal to prepare one for exposure to the public, or only one is prepared by a party or parties who have narrow interests in its adoption. Thus the process of choice is too frequently between accepting one positive option whose anticidents are unclear, or of doing nothing at all. While the latter course often seems inviting, it ultimately leads to a repeat performance in conditions of (or close to) disaster. The need to prepare several options, and of institutions for their preparation, often long ahead of the time of choice, is probably the most important change needed in our form of democratic government.

Because of their tendency to have been given, or to have interpreted their terms of reference that way, both the Economic Council and the Science Council have done the opposite of what is asked here: they have aimed at recommendations, i.e. single options-which could either be accepted, modified without benefit of the original expertise, or rejected.

I believe we need institutions for the preparation of alternative options and the elucidation of their alternative consequences, to put choice back into our political process, in this complex technological age. This need is

urgent in direct relation to the complexity of what is to be chosen (because of the limited time of the chooser before casting his vote), and also in direct relation to the time spans involved in the object of choice. One might be tempted into irresponsible backing of an option the cost of which would be obvious only after one's political career is over.

Thus I believe that science policy changes need institutions devoted to the production and elucidation of the consequences of a plurality of options. I do not think the present tendency to ask for a single package of recommendations will serve.

2.4 Results of innovative behaviour, and the employment Balance

Productivity has been so widely used as a measure of technical change that it is desired to state why it will not serve the purpose of this brief. When long time periods (over 20 years) are considered, only few of the products of society remain unchanged. Thus one car today, or one automotive tire, are so different from those of 1935 that it is almost pointless to enquire into the quantities of effort that were needed for their manufacture then and now: the change in output quality destroys the accuracy of the measure. In a similar fashion, only with great caution can one compare the buying power of money over long time spans, or between very different cultures.

2.5 But advantages other than the technicalities of the previous paragraph are offered by employment as a measure of technical change (as the social and economic result of science). For centuries, increased productivity has been feared by those it displaces, and also applauded as the source of growing (and ultimately shared) wealth. It is often said that increased productivity generates employment. I believe this is true only briefly if at all, and in the long run, quite false. The most sustained improvement in the productivity of any activity has occurred in western agriculture in the last 250 years. In the west, we are certainly better supplied with food than at the beginning of this period. We can now accomplish this production (if we disregard the marginal and submarginal farmers in North America) with less than 1% of our labour force: we needed over 60 times that amount in 1700. Textiles (the subject of the most celebrated industrial revolution), employed up to 1/3 of Britain's working population early in the 19th century. About 3% of our labour force keeps us clothed much better now. The U.S. automobile industry (neglecting road building and repairs) had its peak employment percentage in 1929, though we buy more and better cars today.

2.6 To go back to the automobile industry, we see that before 1900, it employed virtually nobody; then almost 20%

directly in 1929, and a decreasing percentage since. We may say that the technical change represented by its diffusion was labour (or employment) absorbing for about 25 years, and has since been labour (or employment) releasing. There is much technical change which is labour releasing and we need to pursue it vigorously in order to stay competitive. The innovative behaviour in labour releasing changes may be ingenious, but it tends to be fairly rapid, predictable and certain in any given instance. After all, it changes something readily available for observation, trial etc.

2.7 The released labour represents potential wealth, providing it is absorbed in at least equally useful activity elsewhere. Much needs to be done to ease such displacement: Sweden has probably been the most successful society in this respect. But more fundamentally, labour absorbing technical change has to be taken out of the realm of accident in which, for all practical purposes, it has existed up to now. While there has been a flood of such technical changes in the last 200 years, we know surprisingly little about its sources and their management.

2.8 Some of the few things we do begin to see more clearly are: that it tends to be slower of accomplishment than labour release; it is attended by greater uncertainty, which delays both work on it, and the chance of obtaining support for it;

and its paths tend to be so crooked as to defy normal, goal oriented management methods.

Evidence for some of these contentions can be found in numerous studies, of which the U.S. Department of Defense's project "Hindsight" is perhaps the most extensive. The average time to incorporation of these unforeseen events (about 600 in number) was 15 years. In general, the funds for the crucial, small scale initial work was diverted from existing funding rather than separately justified. They occured only where some of the best people were tacitly left unmanaged, if they had proved their worth before. The majority of these fruitful efforts were initially not themselves of a nature that would be supported in the conventional "good" research laboratory-though clearly these workers used science, and often in original ways and for the first time. A later study by I.I.T. (and N.S.F.) showed that the average "age" of such original science at the time of economic accomplishment was around 40 years.

2.9 It is urged by this brief, as a result of these observations, that long range small scale activities of this kind need much more encouragement than they now get in Canada, to balance those labour releasing effects of more rapid improvements in productivity that we also need, to be increasingly

competitive. In fact, without such balance, mere improvement in productivity can have most serious social costs. It remains to indicate why, as such a small nation, we cannot reply on imported technology to provide for these needs without basic technical competence.

10 While deferring a more detailed account of the matter to section the basic reason for advocating some indigenous effort of this type is that its presence here would explain its nature, characteristics and benefits more clearly and certainly than a thousand books: to industry, government and universities, who all need such demonstration. As mentioned in the summary, the small scale ofCanada is still comparable to that of all regions in which such innovative behaviour has let to outstanding economic growth, whether we think of Japan, Holland, Sweden or the successful regions of the United States, such as California in the 1930's-all of whom have imported the vast majority of their technology. In addition to the paper by Prof. Oshima (which is not yet published),parallel evidence for such regionally "infectious" effects of innovative work may be found in Ira Horowitz, I.E.E.E. Trans.ENG. MAN. VOL. EM14, No. 3, Sept. '67, and in numerous specialized sources.

.11 The long time spans referred to represent severe challenges to forecasters, managers and government officers. They tax the limits of uncertainty accessible to (or bearable by)

human beings. They do not fit well into existing large scale patterns of activity. It is not surprising, then, that these activities are not well sponsored, where no tradition for them exist, and that they survive better where either tradition is rich (Sweden, Holland) or where growth from transient phenomena is so fast as to lead to permissive relaxation of management styles (some U.S. regions, Japan, Germany),as well as to ample discretionary capital supplies. In Canada, it seems important to avoid any monolythic Science Authority: here the short term would always drive out the long term.

2.12 The only planning that can be helpful to such long-range activities is not a scientific evaluation by discipline, but a general assessment of the environment Canadians want 30 years from now. Only from such an assessment could one derive areas in which encouragement should be given, and these should represent a very small fraction of what might be imaginable. By their existence, such prophesies are self-fulfilling. Their absence may condemn Canada to the fate of the buggy-ship manufacturers, far sooner than we may wish to believe.

2.13 It is on such ground that this brief feels that the limited planning function suitable for innovative behaviour with labour absorbing aims should become one of the aims of the new Research and Thinking Institute, and not a step-child appendage to a Science Authority.

3. Appendix: Notes on "Technology Imports"

3.1 There has been a tendency in Canada to view the pursuit of any long term technical activity (whether basic research or long-term technological efforts) as justified only in the context of economic and technical self-sufficiency. After referring to Canada's small population and large trade, long-term efforts are then given secondary or non-tangible places in the ranking of our needs. It is hoped that the example of the Japanese pattern of "technological imports", re-inforced with less extreme but still convincing models in other small nations and regions, can go far to correct this negative view of long-term work.

3.2 The Japanese readiness to copy, and in all other ways to utilize western know-how, are too well known to require review. Witnesses from OECD have told you that only recently has Japan achieved the performance of 20% as much technical exports as imports. This was presented so modestly as to hide the formidable Japanese efforts behind this single figure. I should like to examine its background on the basis of some notes from Professor Oshima's Cambridge paper (already referred to in the Summary).

3.3 Japan has an economy about 1/8 the size of the U.S.; they employ 156,000 R+D professionals, almost all on non-defense work. Translating into U.S. terms, then, this would be equivalent to well over 1,000,000 non-defense R+D professionals in the U.S. economy. The actual figure is

around 400,000 (N.S.F. 67-7).

3.4 The money devoted to these Japanese professionals is small, by U.S. and Canadian standards. But, on average, it is 13 times their per capita G.N.P.; in Canada, such a figure would amount to $40,000.00 for each professional. Many things will be denied to the average Japanese researcher: but comparative resources (by internal standards) are favourable.

This large work-force is predominantly in industry, and over 30% are doing "basic research"-and the industries "importing" most technology are also doing most research of their own. These two kinds of work, basic research and search for import opportunities, are regarded as complementary, rather than mutually exclusive.

3.5 There exists a study of 3000 post-war innovations reaching the Japanese market: 600 due to "technical imports". Thus while technical imports far outweigh their technical exports, their own efforts outweigh both by a very large margin. This is for the last 20 years: the rate of increase of their own research effort has been high, and the next 20 years may show even more impressive data on the complementary effects of such dual activity.

3.6 Only one example will be given here of the long-term nature of their orientation. We are much impressed with Japan's pre-eminence in building large oil tankers. We may shrug

this off as due to low labour costs. But we should remember that they built an all-welded battle ship, of over 40,000 tons, in the early 1920's. For over 30 years, this was the largest welded ship in the world.

The man now intellectually, and in terms of power, dominant in this ship-building "culture" joined the industry in the 1930's, and rose rapidly. After the war, while the industry was dead, he undertook graduate studies, and obtained his Ph.D. in operations research related to ship yard organization and work flow. His thesis seems to have been implemented as he rose to final authority.

3.7 I do not believe the typical Japanese innovation of the post war era is accidental, or short term, or snatched by credulous business-men travelling around the globe with smiles and cameras. When I look at the 40 years they took to build their ship-yard and related techniques, and the intensive preparation of their top people over periods of 20 to 40 years, I believe we in Canada have a lot to learn about copying and importing technology: where successful, it is <u>not</u> a matter of buying off the shelf, and needing the service man to come across the border when the equipment goes wrong.

It does need people who know what goes on in the world, who have the courage and discrimination to buy what suits them best, from the secure and proven basis of being able

to do almost as well in any case, and better more often than not; but at all times keen on, and intensely aware of excellence, and the pains and persistence required for its achievement.

CURRICULUM VITAE

F. ERIC BURKE, Associate Professor, Faculty of Engineering, University of Waterloo since 1967, now in Department of Management Sciences. B.A.(London) 1945, M.Inst. Mech. Eng. (U.K.), C. Eng. (U.K.), P. Eng., (Ontario).

After five years industrial experience in development engineering and process equipment design, and a further five years with technical and scientific consultants in the U.K. he came to Canada in 1952 and joined Can. G.E. in Montreal. While Manager, Materials Research Laboratory, 1956-67, Canadian General Electric Company, Toronto, Professor Burke has directed applied research into thermal and physical properties of high-strength polymer composites, electrical discharge phenomena and their detection, and dielectric materials ageing, resulting in more than 20 major internal reports, his assistance in the direction of several U.S. (G.E.) projects, and invited lectures at M.I.T. and the National Academy of Sciences. He was formerly a consultant to Corporate Management in New York of the General Electric Company,on strategies and organization for research and development. He is the holder of patents in connection with electrical-mechanical-chemical processes and devices, and presently holder of a major Killam Award from the Canada Council for research in "Types and Processes of Innovation, Technical Change and Society". His current

research interests include empirical determination of utility functions, human and physical information limits, organization theory under conditions of high information loads. He is a consultant to various governmental and private agencies on Science Policy, Manpower Planning, and Research and Development Policy. He also serves as a Lecturer in Mechanical Engineering at the University of Toronto, in a graduate seminar on heat transfer with change of phase.

His articles and papers include:

"The Theory and Practice of Tensile Elongation Measurement' S.P.E.J., (1963)

"Partial discharges with non-symmetrical electrode pairs" (with E.A. Atkinson),

Proc. Diel. Conf. (1963) National Academy of Science/ National Research Council

"Science and Government, the Users' Viewpoint". CBC Feb. 1966 (mimeo).

"Compromize Fuel Batteries-a benefit/cost analysis" 2nd. Canadian Fuel Cell Symposium, Montreal, Sept. '66

"Notes towards a general theory of innovation" Department of Management Sciences (mimeo), (1965)

"Interim report on the Killam Award project 67-0157", Department of Management Sciences (mimeo), (1969)

"Logic and variety in innovation processes" in Technical Innovation and the Growth of the National Economy Wiley, (in press).

APPENDIX 184

BRIEF TO THE SENATE SPECIAL COMMITTEE
ON SCIENCE POLICY

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SUMMARY

The brief is presented as follows.

APPENDICES

1. Tabulation of Significant Points From Previous Submission to the Special Committee on Science Policy

2. Table of Comparison Last Three Years of High School (Science Oriented) U.S.A. and U.S.S.R.

3. Typical Correspondence Course Lessons Wolsey Hall, Oxford, England for Science Subjects Corresponding to Canadian Grade XI and XII

4. The PhD in Industry

5. The Training of New Intake Engineers for the Pulp and Paper Industry

6. The Eight-Year Career Development Plan - A New Tool in Personnel Management

7. Typical Science Text Books Content U.K. - Grade XI and XII

PREFACE

The following brief is presented from the viewpoint of two working technologists with, as far as we know, no axe to grind, except the life-long desire to see things done properly. In part we may have appeared presumptuous; where this impression may have been created we apologize to the Committee. It is our understanding that the views of the technological and scientific community were sought and we have presented ours in a positive style that others perhaps may think unjustified.

We plead indulgence for any deficiencies; the preparation of this brief has been entirely a spare time activity. If the Senate Committee wishes to hear us then, like the Greeks of old "Having done what men could we will (be glad to) suffer as men must."

CONCLUSIONS

1. Industrial research and development is not as effective in Canada as it should be. Effort devoted to educating general Management with regard to the rules and constraints of research and development, how it must be organized, what can reasonably be expected and how long it takes, appears to be the most direct and practical solution. The level of research Management in Canada should be raised.

2. Our educational system is deficient in that

   (a) our high school students are insufficiently trained in scientific subjects when they reach the University. This results in a considerable loss from scientific and engineering courses in the early years. In turn the engineering courses acquire a reputation for difficulty that discourages entrance to them.

   (b) we are educating our scientists and technologists for an unreal rather than a real world. This is most clearly evident in the "PhD cycle".

3. "Technical Obsolescence" will impair the productive application of science and technology. Study periods should be encouraged for practicing engineers to refurbish their technical competence. To make possible periods of study of more than a few weeks, an enlightened leave of absence policy should be supported at a national level.

4. Canadian University graduates do not easily assimilate into industry. This is a common difficulty in most developed countries. Training schemes to facilitate the transfer from University to industry should be available in all industries. Academic staff should be involved in industry.

5. The current patent system should be retained subject to such practical measures of improvement as may be possible.

6. Adequate technician back-up is needed to achieve maximum productivity from engineers and scientists. This back-up is still not sufficient in Canada.

7. There are few women scientists and engineers. This constitutes a waste of brains to the nation.

RECOMMENDATIONS

1. Regarding Education

(a) The existing Canadian educational systems should be re-examined by a representative group containing no professional educationalists but provided with such professionals as advisors.

The examination should be with reference to the teaching of science, the numbers taught and the level of attainment reached at discrete stages in the educational process.

(b) The government should finance exchange professorships between industry and universities.

(c) "A National Leave of Absence Policy" should be produced and implemented. The principle of such a policy would be to underwrite, on a realistic financial basis, the further education of engineers and scientists of proven ability working in industry and, thus, avoiding technical obsolescence.

Such a policy would also have the effect of breaking "the PhD cycle". - See text.

(d) Exchange scholarships should be set up to enable technical and scientific workers of proven ability to spend time in other countries. These are envisioned as being similar to the Athlone Fellowships but would cover working in industry in another country and would be financially realistic.

(e) A National Engineering Academy should be set up. This would be composed of the most prominent engineers and technologists in the country. Election to it would constitute an honour. It would bring together periodically eminent men of different disciplines, and it would serve as a source of advice and reference.

2. Regarding Patents

(a) The recommendations of patent attorneys should be sought with regard to simplification and improvement of the patent system bearing in mind the two basic principles of the said system, viz:

(i) a patent is essentially a bargain between the state and the inventor

(ii) the system is intended to provide incentive for disclosure so that the state may benefit

(b) The elementary principles and procedure of the patent structure should be publicized at regular intervals.

(c) Honorary committees should be appointed for each industry to pass on the merit of proposals so that the cost of patent application can be met by the state in deserving cases.

3. Regarding Research and Development

(a) The government should run two courses at an appropriate yearly frequency.

Course 1 would be for top Management in Canadian industry. The principles of organization and management of research and development would be explained in this course and case histories of suitable major and minor discoveries would be used to illustrate it.

Course 2 would be for those concerned in research direction and management. It would be intended that on this course the basic "rules of the game" would be explained and illustrated.

(b) Certified courses in market research should be organized and set up either at a University or equivalent or as special courses.

4. Regarding the Use of Scientific and Technical Literature

(a) Courses in the use of the scientific and technical literature should be encouraged and certified if of appropriate standard.

(b) Courses in technical report writing should be encouraged and certified if of appropriate standard.

(c) A series of government sponsored, adequately stipended and prestigious lectures should be inaugerated to make clear the present state of technology and cause our industrial managers and technologists to ask themselves "are we doing this now?"

5. Regarding the Improvement of Canadian Industry

A free management consultant training service should be set up and maintained. It is not suggested that the government should set up a consultancy service, but that most companies could benefit from management consulting and that they could set up their own teams if they were shown how.

6. Regarding the Division of Funds Available to Science and Technology

A survey should be made to compare the funds generated by the different industries comprising the national economy and the funds allocated to them for research and development; for example, agriculture, pulp and paper, automobiles, mining, chemical manufacturing.........

7. Regarding the Research and Development Activities of Companies That are Subsidiaries of Foreign Companies

Above a certain annual income such companies should be compelled to carry out the due proportion of their research and development work in Canada.

8. Regarding the Maximising of the Contribution of Existing Engineers and Scientists

(a) Re-education as in 1 (c) should be positively (financially) encouraged.

(b) A study on technician supply and demand, quality and quantity should be made on a regular schedule. Effort should be applied to increase the technician graduate ratio to the appropriate level.

9. Regarding Systems Engineering

(a) Universities should be encouraged to set up systems engineering courses. These should be designed at a level to benefit industry rather than the professor. (The University of Lancaster course is about the ideal.)

(b) Companies should be encouraged to invest in the activity of systems engineering. Suitable courses should be organized for Management.

10. Regarding Women

The women power of the country should be given opportunity to participate in engineering and science on equal terms with men so that we may put the best brains of the country to work instead of only those of the male half.

INTRODUCTION

Planning may be defined as "the preparation of a system of organization of events with the purpose of securing a desired objective with the conservation of scarce resources".

The levels of planning can be considered as being:

1. personal planning family, insurance, budgeting, education, health, vacation and career

2. local planning

3. company planning, e.g. research and development, sales, engineering, manufacturing

4. corporate or long range planning

5. military planning

6. national planning

A policy can be considered as the guidelines that will assist planning. A science policy for Canada would, therefore, be the guidelines for the planning of the development of science and the associated technology to the national advantage. The policy is, thus, one that will guide planning at the highest or national level but which will also affect planning at all lower levels.

Before the present authors can submit their brief, it is necessary that their understanding of what a science policy for Canada should contain should be expressed.

If this is to be done it is appropriate that the "scarce resources" referred to in the definition on planning be enumerated. We understand these to be health, money, amenities, material, scarce talent and time.

It is respectfully submitted that in formulating a science policy we should be concerned with conserving the above.

Our understanding accordingly is that a Science policy for Canada should be framed with consideration of the following eight points:

1. Encouragement of proper planning at all levels of activity in the nation.

2. Maintenance of the national amenities.

3. Encouragement of scientific and technical education in a manner that will provide the manpower of a type and level that is and will be needed.

4. Maintenance of the health of the nation.

5. Encouragement and development of outstanding individuals.

6. Avoidance of waste of our natural resources.

7. Use of the funds available in a planned manner in the national interest - avoidance of the diversion of excessive amounts to prestige projects or as a result of vociferous "pressure groups".

8. The achieving of expedient results in the national scientific effort, both in work done and in its application.

It will be observed these are in many respects similar but not identical to the six national goals suggested by the Science Council of Canada (1). The most important differences are the omission by the Science Council of the maintenance of amenities and the fact that the present authors have not considered above the effect of Canada's effort on the underdeveloped nations as part of science policy, although such effects are referred to in the text which follows.

Guided by the above concepts, we have studied the proceedings of the Special Committee on Science Policy and have annotated those points of submission that have appeared to us as particularly significant. Appendix I presents a tabulation of these points grouped in an arrangement which we felt may be enlightening.

Our own submission is given sequentially by section. The Conclusions we have reached and the Recommendations that we make therefrom are presented at the beginning of this brief.

1. Patents

There is a considerable amount of emotion and misconception uncovered whenever the patent system is discussed. Whilst of British origin, Reference (2) will be found of value in explaining the patent system. Alex MacRae indicates in his book (3) the particular points of Canadian practice.

One of the misconceptions that frequently is found is that the patent system exists merely as a desirable means of rewarding an inventor or other invention owner for the genius, time and money expended in the development of an invention. If this misconception exists in the mind of anyone seeking to evaluate the patent system, it is essential that it be dispelled.

Common law rights of inventors have been recognized at least as far back as the fourteenth century. A man's ideas are his personal property and no one should steal them. In ancient times there was no state reward for a man's inventions and, as a consequence, inventions were frequently kept secret.

It should not be forgotten that for centuries China was a leader in technological advances in many industries. Papermaking and the compass are examples of Chinese inventions. Techniques in these and many other fields were, however, kept as family secrets, presumably because China had no patent system. Thus China did not maintain its lead in science and technology and for several centuries has fallen behind in development in these fields.

The proposition that the state as a whole would benefit by stimulating the development of new inventions with consequent establishment of new industries has been recognized for hundreds of years. The related proposition that the public disclosure of inventions would promote the development of science and the arts by arousing others to bring forth improvements in such inventions was also recognized as far back as the fourteenth century.

Obviously, of course, some inducement had to be offered to the owners of intellectual property in return for:

1. the establishment and promotion of new industries based upon new inventions

2. the public disclosure of inventions

This inducement usually took the form of an exclusive monopoly for a limited term.

In early days inventors were not too confident that they would, in fact, receive the desired reward. We all know of Leonardo da Vinci (1452-1519) as an inventor of genius. His notes indicate that he invented the screw cutting machine, the lathe, ball bearings and many other devices, including a flying machine. For the most part he preferred to keep his inventions secret.

Edward III granted letters of protection to various craftsmen in order to promote industry in England. Edward may well have had an ulterior motive since even in the fourteenth century business taxes were levied and the Crown derived direct benefit from such taxes.

It was very early realized that the granting of a reward to an inventor in return for disclosure of his invention was the only fair and honest step to take. Early inventors, such as Galileo were quick to point out to their rulers that they were entitled to recompense as "the fruits of their rights and labours" and rulers such as Queen Elizabeth I and the Prince of Venice (In the case of Galileo) recognized their requests as valid.

The Republic of Venice appears to have been the first state to pass an act (in 1474) establishing a system of granting monopolies for new inventions for a fixed term.

The Statute of Monopolies, passed by the English Parliament in 1624, voided most monopolies in existence at that time and set up a system of granting monopolies, based upon existing common law rights, that is the basis for most patent systems of today.

It is worthy of note in the connection of a discussion on "A Science Policy for Canada" that the Constitution of the United States includes the clause:

> "The Congress shall have Power ...... to promote the Progress of Science and useful Arts by securing for limited times to Authors and Inventors the exclusive right to their respective Writings and Discoveries".

United States courts have on many occasions held that the main purpose of the Clause was "to promote the progress of science and useful arts" rather than to reward the inventor though the latter was always recognized as an obligation. The U.S. Supreme Court in a modern-time decision state

> "The invention to justify a patent to serve the ends of science - to push back the frontiers of chemistry, physics and the like; to make a distinctive contribution to scientific knowledge".

Nearly two hundred years have elapsed since the United States Congress passed its first patent law. When one considers the technological and industrial position of the United States in the world today, it is trite to point out that the constitutional clause quoted has had the desired effect.

In the nineteenth century, Morse for the telegraph, Goodyear for vulcanized rubber, Bessemer for steelmaking, Westinghouse for the air brake, Bell for the telephone, Edison for the electric lamp, Tesla for the induction motor, Diesel for the Diesel engine, Marconi for the radio, and Wright for the airplane all obtained United States patents. In other words, these outstanding inventors without whom achievement in science and the arts would have been greatly delayed, utilized the patent system in order to gain their rewards for disclosure of their inventions.

If patents in the eighteenth and nineteenth centuries played a major role in the advancement of science, their role today is many times greater. The day of that multi-million dollar research laboratories are often necessary to provide the facilities required for research. DuPont spent ten years and 27 million dollars to produce "nylon" as a commercial product and eight years and 25 million dollars to produce "Orlon" as an acceptable commercial product; that they would have done so without the promise of patent protection is obviously a ridiculous thought.

The electrostatic copying machine and the polaroid camera are two other modern inventions which may be cited as examples of inventions by individuals who fortunately obtained patent protection without which they would not have been able to obtain the necessary financial backing in order to develop and commercialize their inventions.

The important aspect of their and other inventions, to which we wish to draw attention, is the fact that new industries and employment opportunities occur because of the availability of the products of the inventions.

In the field of pharmaceuticals research is extremely expensive and is undertaken only because of the promise of reward. It has been said that only one in thousands of, for instance, antibiotic compounds produced and tested is of practical value.

Some countries in the belief that pharmaceuticals are closer to human welfare than other products, do not grant patents on pharmaceuticals. Many do not share the attitude. Who is to say that, for example, a new surgical appliance or instrument or a safety device for motor cars is not just as close to public welfare as a pharmaceutical?

In any event it is not at all consistent with the basis of the patent system to fail to grant patents on pharmaceuticals since this is one field in which it is highly desirable to promote development of new and useful products by research and disclosure in return for the necessary compensation. Dr. E. Jucker has drawn attention to these adverse effects of what he calls "hostility to patents" in Reference (4) which is recommended reading.

Italy is an example of a major country that does not grant patents on pharmaceuticals, but does in other fields, including industrial chemicals; under a new patent law presently proposed but not in effect special patents will be granted in the field of medicines.

Italy is a world leader in many branches of industrial chemistry, where patent protection is afforded but lags far behind in the drug industry. The country has more drug producing laboratories than the United States but 90% of them produce only drugs of known formula. Less than 10% do any research at all. The cost of drugs is still quite high.

One of the reasons for the proposed new patent bill is, of course, the distasteful suggestion that Italy is "riding on the coat tails" of other countries in that as soon as a new and useful drug is produced in another country, the Italian laboratory is free to make and sell it without any reimbursement to the foreign patent owner.

Canada's position in the patent world is unique in that about 95% of its patents are owned by non residents. This is largely because of the fact that we are sitting on the doorstep of the United States, the most industrialized country in the world, and whose ownership of Canadian patents constitutes about 75% of the total. We have accepted an enormous amount of United States capital in the development of our industries. A large part of the attraction of this capital has been due to the patent protection granted by Canada in a degree substantially corresponding to that existing in the United States. The attraction of foreign capital as a result of our patent system may be said to have been a major factor in the industrial development of Canada.

Canada has not, however, lagged behind in scientific research spurred on by disclosure of patented inventions in this and other countries. We consider the National Research Council laboratories to be among the best in the world, and they annually produce many patentable inventions. In mining and fuels the laboratories of the Federal Department of Energy, Mines and Resources are also well equipped and staffed and likewise produce many patentable inventions. Those and other similar governmental agencies, always patent their inventions as their contribution to public knowledge and industrial advancement and as a reward, in prestige to the inventors. These agencies also frequently receive compensation from licenses in Canada and other countries where corresponding protection has been obtained.

Private industry in Canada also leads in many fields of scientific development as a direct result of our patent system. In the pulp and paper industry virtually every company operating in Canada has a research department even if not of the desirable size. Such inventions as are made are not kept secret but are disclosed to the public in patents so that research workers are kept abreast of modern developments, avoid undue duplication of effort and direct their attention to the most appropriate fields.

The millions of dollars that are spent annually in Canada on private research are spent only in the expectation of reward in the form of a fixed term exclusive monopoly.

We suggest, therefore that the inventor, be he obscure or not, develops his invention because of an innate curiosity and desire to produce something new and useful, but that having developed it, wishes something in return to recompense him for his expediture of genius, time and money or to set him apart from his more slothful brother. The world if it is to gain his knowledge and thereby "promote the progress of science and useful arts" must pay for it.

There may be a better system than the patent system for this purpose but in six hundred years of close attention to it, no one has proposed a workable alternative one.

As is clear from the foregoing, the authors believe in the patent system. We suggest that the existing Canadian system be re-examined by a competent group of patent attorneys to see how, whilst keeping the essentials of the system, improvement may be possible.

2. The Educational System

No subject is more charged with emotion in North America than the educational system. He who discusses it is truly venturing where Angels fear to tread. No trade union, even that of the medical profession in the various Canadian provinces is as strong and as vociferous as the invisible trade union of professional educators.

Nevertheless it is not possible to fully discuss the subject of a science policy for Canada without reference to education.

It is difficult to speak of the Canadian educational system as the standards vary so widely. The educational system is, however, basically similar to that of the U.S.A. with a few variations inherited from Britain. For those who wish to acquire a broader background in this subject the book "Four Hundred Years of English Education" is recommended (5).

The American system, after which ours is modelled, has been considered by some lucid and logical thinkers to be deficient. Noteworthy amongst these is H. G. Rickover whose books "Education and Freedom" (6) and "Swiss Schools and Ours Why Theirs Are Better" (7) make fascinating reading. In an earlier report to the U. S. Congress (8) Rickover compares the U.S. and Soviet school system. A good account of the Soviet system is given in Reference (9). Professor Stephen Timoshenko, whose native language is Russian, and after whom the ASME Timoshenko Gold Medal is named, describes Engineering education in the Soviet Union in a monograph that is priceless (10).

It is our view that the Canadian educational system does not produce efficiently the educated scientist that we need and that many of the explicit criticisms of the American system made by Rickover and the implicit criticisms made by Timoshenko are true also in Canada. As an example of the difference between the U.S.S.R. and the U.S.A., Appendix II is presented. This is a table comparing the last three years of education in science under the two system from Reference (11).

The Canadian educational scene is now invaded by the new mathematics. Dr. J. M. Hammersley of Trinity College, Oxford, a world famous mathematician, has written on this and kindred subjects (12) under the title "On the Enfeablementof Mathematical Skill by 'Modern Mathematics' and by Similar Soft Intellectual Trash in Schools and Universities".

It is our belief that the standard in science reached by Canadian schools is gravely inadequate. This carries over to university and makes the transition to university more difficult than it should be resulting in a disproportionate number of failures and a reputation garnered by science and engineering courses as ones to avoid.

The present submission is not the place to go into this subject in detail. Appendix III, however, contains typical correspondence course lessons* corresponding to our Grade XI for the English system and gives an idea of the difference in standard. Reference (11) may also be consulted for further information.

Whilst one may consider the question of Canadian linguistic ability, in relation to our school system, to be but distantly related to the question of a Science Policy for Canada, this is not necessarily true. Firstly, the state of linguistic capability in our schools is to some extent a benchmark by which the standards reached may be judged. It is hardly necessary to comment that for most of Canada, as for most of the United States, the standard is lamentably, even laughably, low. Secondly, a good working knowledge of at least one language other than his own and preferably of two or three, is an essential tool in the international scientists tool kit.

Nor can it be said that Canadian universities are producing trained scientists and engineers who correspond with those needed by Canadian industry to attain our national goals. It should not be thought that this is a peculiar situation to Canada; it is international - a malaise of the second half of the twentieth century. Admiral Rickover, whose two books and report to the U.S. Congress were referenced earlier, was driven to his critical evaluation of the U.S. school system by the fact that he found university graduates wanting. The British have recently been examining this subject in depth as evidenced by References (13), (14), (15) to which reference will later be made.

As we see it, our Canadian system is deficient in two respects. Firstly, we produce too many PhD's who are part of a self-perpetuating cycle living in an unreal world. This cycle can be diagramatically represented as in Figure 1 which follows. Whilst this figure is not true in all cases, it is in a surprising number.

This system resulted in the undergraduate becoming imbued with the idea that science and technology in industry are for the relative failures. In the event that a capable young man does not go on to study for a higher degree the odds are that he is imbued with the ambition of becoming a manager overnight and so he goes off to a school of business administration and his technical talents are effectively lost to the nation.

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* From the correspondence school, Wolsey Hall, Oxford, England, reproduced by permission.

That all is not well with our PhD assembly line has already been brought up to the Committee on Science Policy; for example, References (16), (17). We agree with and support Dr. Gray's suggestion that encouragement be given to the doing of work in industrial laboratories for higher degrees.

We would stress that from our own experience the best degree level to absorb a man into industry is with a Masters degre. A man with a Masters degree and two years rigorous and well-planned industrial training is not only worth more immediately than a PhD to his company, but is likely to be of greater use to his country during his whole working life.

Rather than belabour this point further, we attach as Appendix III a lecture given by one of us three years ago (18)"The PhD in Industry". This lecture is noteworthy for two reasons, quite apart from the views expressed; there are the extracts from letters from men in the pulp and paper industry of established reputation, world-wide in extent, and the tables showing the distribution of graduates from the two largest English speaking schools producing PhD's for the pulp and paper industry. Rather than expand this brief excessively it may be more appropriate to discuss these points orally.

The second deficiency in our system has already been noted above "en passant". This is the attitude of many, if not most, of the scientists and engineers that our universities turn out. They are not imbued with "professionalism", but instead with the ideas of the slack and easy society. Many do not want to apply themselves to the degree needed to achieve engineering success. Many have the "instant management" ambition - without having to do things in an engineeringly proper manner, they will "slide by" on their way to a management position. It is becoming more difficult to find motivated young men who are worth putting one's personal time on for training them.

To change this attitude will necessitate changing the attitude of the teaching staff. It may be properly asked what suggestions do we have for doing this? It is clear that the industry-university interaction must be improved. This could be done by:

(a) Establishing interchange between senior industrial scientific workers and university professorial staff.

(b) Encouraging industry to use Professorial staff on industrial problems, particularly doing summer vacations.

(c) Providing encouragement for graduates to work for three years in industry before taking their PhD.

(d) Using Professorial staff to teach courses in company further education schemes at industrial locations.

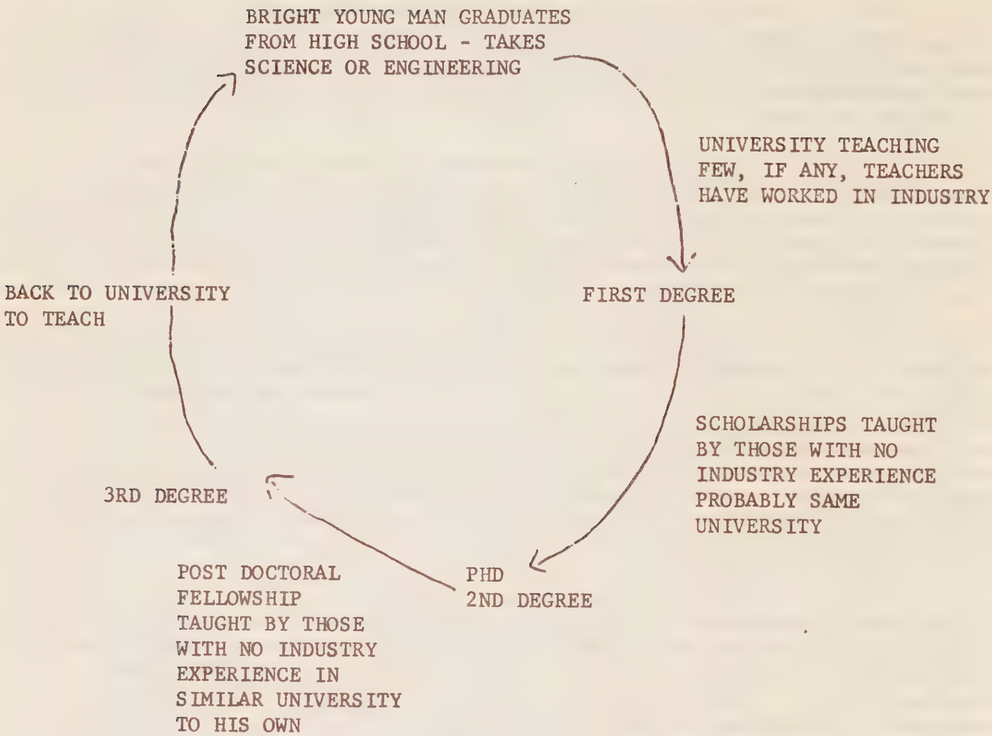

FIGURE I

THE PHD CYCLE

Professor Linnett* has summarized the Swann report (14) as follows.

(a) Too few scientists, engineers and technologists from the universities are becoming school teachers and that, unless the flow can be improved in quality and quantity, this will be disastrous to our scientific life and to the industry of our country (Britain).

(b) That too small a proportion of our high quality young scientists, engineers and technologists enter industry.

(c) That universities should study how their courses can be better designed to produce the type of graduates in science, etc. that industry needs.

(d) That universities should examine their post-graduate training (and in particular the PhD) so that it will be more closely oriented to the requirements of industry.

(e) That intensive courses should be provided for those working in industry so that they can acquire fresh outlooks and skills and deal with the rapid growth in science and technology.

(This item (e) is included here for completeness; it is dealt with later in the brief by J. Mardon and J.S. Root.)

Professor Linnett comments "with regard to the flow of scientists, engineers and technologists into industry, university science teachers must either accept or answer the opinion expressed by many 'industrialists' that 'the PhD is the root of many of our troubles'".

In a similar vein the editor of the Royal Institute of Chemistry journal (19) notes the industrial viewpoint as "A PhD is worse than useless, since not only does it make its possessors far too research oriented, but it gives them ideas above their true station" and again "In the long run, therefore, either we are going to end up with a slate of unemployed, unemployable or under-employed specialists.......". "Neither universities nor industry should act before thoroughly consulting each other."

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* Professor Linnett holds the chair of physical chemistry at the University of Cambridge

For a summary of the Swann report the review of Dr. Davies* (20) will be found time-saving, though the full report deserves study.

Mr. M. C. McCarthy** in his comments on the Swann report (27) notes that "the educational system of today is the manpower supply of tomorrow". In our words a Science Policy depends on having the scientists. We must both produce the kind of scientists we need and maximize the use of those we have - this latter point we return to later.

It is our suggestion that the Canadian educational structure be examined by studies similar to those carried out in Britain (22), (23), (24), (13) with a view to determining how scientific capability may be best developed in a form that is usable in the attaining of the national goals or objectives.

It should be understood that neither of us hold any particular brief for the British system as such (21) and for this reason the lecture (11) was primarily based on the Swedish system as it then was. However, the British have endeavoured to deal with this matter and their failing is not in the quality of the reports but in the order in which the studies were made and in what the government did about the recommendations. We suggest that we should take advantage of the help these studies give whilst avoiding the mistakes that can now be seen.

It should not be thought that the views we have put forward are popular and there are not wanting those who consider that all is well with our system because the United States and we in Canada have a high standard of living. Such comments merely serve to force home to us the fact that common sense is a most uncommon attribute. A point of view to which we do not subscribe is put forward by McCarthy (25) where he asks only for more "generalists" without considering in lauding the U.S. system that technologists, engineers and scientists in industry must first be fully competent in their chosen profession. His article is a serious contribution and should be read. We do, however, agree with his emphasis on further education for practising technologists which forms the subject of Section 4.

Several textbooks for Science Grades XI and XII, English school, are attached as Appendix VII and might be compared with the standard in Canada. Swedish, Dutch, Swiss and Soviet schools reached an even higher standard.

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* Deputy Chairman, Mond Division, I.C.I.
** Stirling University

3. The Training of New Graduates in Industry

Whilst industry justly complains about the product that the universities serve to it, the universities also complain with a considerable amount of justice, that industry does not know what to do with graduates when it gets them.

In a recent lecture (25) one of us delineated the conditions which, if present in a company, will retain technically trained and competent technical personnel in it as:

(a) Interesting work assigned in a manner that permits recognizable achievement.

(b) Adequate compensation; fair (and known to be fair) practices in adjustment.

(c) Recognition of achievement by superiors.

(d) Clear recognition of the possibilities for advancement.

(e) Vacations.

(f) Training on a planned basis.

(g) An intelligently formulated and liberal policy with regard to publications so that recognition by the peers of the profession is possible when merited.

(h) Participation in committee and society work.

(i) Attendance at conventions and technical meetings.

(j) Location.

(k) Physical facilities available.

Many of these conditions are appreciated by various levels of management in any company and lip service is often paid to the observing of these conditions. Training is one area in which many companies could improve and nowhere more than in the indoctrination and training of new graduates.

To avoid undue repetition, Appendix V is provided (26).

The usual failures in "in company" training programs are:

(a) The program is conducted on the "sink or swim basis" in which a new graduate is circulated amongst departments for a planned period in each. Such programs frequently look well conceived when examined superficially. They almost always suffer, however, from the following deficiencies:

(i) No detail is provided for the program; the detailed training provided is, thus, left to a busy supervisor who may not be a natural trainer of others. The success of any training program depends on the amount of organization and work that has gone into it. If no work is put into the organization of a training program, then it will only serve to disillusion and depress the new graduates submitted to it.

(ii) The program approved by the Management at one level is not fully implemented at a lower level. Too often the ethnic in vogue after two or three months becomes "to hell with the training program we've got work to do".

As a result of this mode of operation in the training cycle, the engineer is never fully trained and is resentful that at a later date he must waste much time learning inefficiently something that he should have learned during his initial training period.

The situations described under (i) and (ii) filter back to the universities and predispose the students against working in industry.

Reference (26) describes the "tutorial" method of training which has been found to be an answer to the defect (i) noted above but naturally is still liable to defect (ii). A fuller explanation of this system which has helped produce many outstanding engineers, was contained in a submission made in 1967 to HRH the Duke of Edinburgh.

We consider that in Canadian industry at large the arrangements for the handling of new graduates during their first one to two years are frequently inadequate. Effort to improve this situation must contribute to an improved use of graduates and better recruitment from the universities. We, thus, believe it should be a matter for the committee to investigate.

4. Further Education of Practising Engineers

In the discussion presented above, the subject has been referred to in point (e) of Professor Linnett in his summary of the Swann Report (Section 2) and also by McCarthy in his plea (27). It has also been raised in the discussions before the Senate Committee (28) (29). (If we may be allowed a personal note, we feel in harmony with Dr. Gray when he says "there are retraining programs for all levels except mine".)

The pace of science and technology today is such that retraining or as we call it, "retreading", is necessary at intervals, for the practising scientist and technologist. If he does not keep up to day then as he becomes first obsolescent and then obsolete, he must either move into administration, where, being out of touch he is incapable of either supervision or of maintaining the respect of his subordinates, or he must be shunted into some administrative or technological back alley where he can do no harm. We agree with Dr. Selye (34) that unnecessary time in administrative work is wasteful as far as science is concerned.

When this happens on the small scale, it is demoralizing for the man and his family; on the large scale, it represents a vast waste of the country's resources. We do not believe that as a man gets older he necessarily loses his scientific and technical productivity (30), (31), (32). What we do believe is that

(a) those who never really had any scientific and technical originality but who were pedestrian workers doing their bit, can no longer compete as they get older

(b) even the best of men once shunted to an administrative post, often as a genuine promotion, can no longer train themselves to keep up to date in their spare time.

Our conclusion is, therefore, that we must train and retrain our practising engineers and the views we held have been set out in Reference (33).

The methods available are:

(a) Self-study; keeping up to date by reading technical articles and papers
(b) short courses - 2 - 3 weeks
(c) correspondence courses
(d) long courses - several months
(e) evening study
(f) leave of absence for full study

We consider that every inducement for retraining by items (b) (c) (d) (e) and (f) should be provided. However, it must be recognized that these methods are (b) and (d) dependent on the company concerned and (c) (e) frequently too time consuming for an engineer who has considerable job and family responsibility. We believe that the solution to the retraining or rather continuous training of engineers lies in the following.

(a) Special short courses organized on an intensive basis on one weekend out of four and linked with a one or two week summer school.

(b) A progressive leave of absence policy for full time study.

Reference (33) contains the results of a survey on the subject conducted among the largest corporations in North America, and also contains the type of leave of absence policy recommended by the present writers. It is our belief that no expenditure of government funds would better serve the economy than by underwriting a leave of absence policy for practising engineers.

A similar point of view to that of the present writers and of the authors of (33) is reflected by Dr. D.S. Davies referred to previously in his article "Club Sandwiches" for scientists (35) Dr. Davies argues the situation suggests that the educational pattern be reconsidered and be regarded as a multitiered educational "club sandwich". On this basis the first stage would be concerned with the establishment of sufficient basic competence to perform and achieve usefully in the area that one would have chosen under the present system, but with the clear recognition that further study is yet to come. This would release the student from the oppressive need to stack up knowledge as part of the present, once for all opportunity for full time study. Davies' article should be consulted for the later stages he considers at ages 27, 40, and later.

Any science policy for Canada must take cognizance of the fact that to obtain full use of our engineers and scientists, they must be provided with the technician assistance appropriate to the task in hand. Consideration must, thus, be given to the education and training of technicians in a manner such that demand is foreseen and supply and demand balance. Reference (36) is a typical United Kingdom publication dealing with an investigation into one specific technician category. Similar studies appear warranted in Canada.

Kursanov (37) has pointed out that one must be careful not to oversupply technician assistance at too early a stage. The question of providing laboratory assistants for such young scientists must be decided more cautiously as premature assistance may reduce their own participation in the carrying out of the experiments. For this reason, assistance may be provided for the first time only when the young scientist has attained great skill in experimentation and acquired a sufficient breadth of view to evaluate and select methods of work, and when his scientific initiative has attained such scope that he cannot carry out all his projects unaided. And then the assistant must be provided, not to release the young research worker from personal participation in experimental work, but only in order to speed up this work.

At the beginning of Section 3, it was noted that training on a planned basis would be one of the requisites for a satisfied and motivated technical work force. Initial training and further education have been dealt with above. As well as continuing education, training in the business is also needed, if a man is to progress; it must also be appreciated that further education is designed to be useful and, thus, must be linked and in harmony with a man's professional progress. To take such a broad view seems difficult for most - one way is the use of career development plans as described in Appendix VI.

5. Research and Development

Much time has been devoted to a discussion on this subject before the Committee. We were particularly impressed with the testimony of Dr. J. L. Gray with which we found ourselves in complete agreement; the points which we considered of maximum significance in his presentation we have isolated in the table in Appendix I.

Our views are basically those laid out in the monograph by J. Mardon and L. D. Mardon (38). As this monograph is only eighty pages long and is in itself a condensation of twenty years thought, it is pointless to reproduce ithere. We consider that R and D can be considered on the basis of fifteen premises that are given below:

(a) Productive research depends on a department having one or more genuinely creative men, one of whom must be in a senior position.

(b) Judgment of the talented research director is the yardstick. The talented research director's judgment must guide the operation and assess it in the short-term.

(c) Financial assessments are only truly representative over a long period.

(d) The wild "scientific management" methods proposed by such organizations as the various schools of business administration are useless.

(e) Service work and research work must be effectively separated.

(f) A carefully thought out mechanism is necessary for implementation of development work, which must be carefully distinguished from research work.

(g) All available information originating from inside and outside the research department should be utilized.

(h) The proper working conditions must be provided so creative men of the first rank will join - and stay with - the research organization.

(i) The staff must be trained.

(j) The administration must be first class; it must support the scientists so they are free from unnecessary administrative detail and can get on with the work.

(k) Projects must be selected with discrimination, written out to illustrate scope and objectives, and planned thoroughly.

(l) The men working on a project must be protected from interruption.

(m) The supervision must be kept in touch with all work in progress so guidance is available when needed.

(n) The correct reporting discipline must be established.

(o) Every project must be finished at a logical stopping point and written up so useful results are available later, even if the original urgency no longer exists.

Further reading on the subject pertinent both to the conduct of research and development in Canada and to the utilization of its results in a productive manner are Reference (39) to (44). Readers of this brief should not be mislead by the title of Mitchell's lecture. It probably contains more relevant facts to the page regarding the "research and development system" than any other publication. A full list of references including many from the Soviet literature is given in (38).

It is our view that we do not obtain full value for the effort expended on research and development in Canada for the following reasons:

(a) The basic rules of how research and development works are frequently not appreciated by top Management who, thus, cannot evaluate research in progress and frequently suffer from a sense of frustration. It is also common that too much is expected too quickly. Conflict arises from a misunderstanding between what <u>needs</u> to be done and what <u>can</u> be done (43).

(b) Frequently the rules for the effective management of technical personnel are not followed.

(c) Older personnel become unproductive because of lack of training.

(d) There is rarely a "dual channel" of promotion that will enable men of real capability to advance in a technical line of progression without having to take on administrative responsibility that will slow them down technically.

(e) There is conflict between production and R and D (43). It must be appreciated that to some extent this is inevitable since production desires a status quo whereas R and D causes change.

(f) Creative men are frequently not identified or not developed and when they do exist are often not given the free hand they need to produce.

(g) As in all countries, there is a "technological chasm" between an idea and its development as a commercial practicality.

The above points are world-wide in their applicability and may be illustrated by quotation from Sir Cyril Hinselwood (45) who pointed out

"A popular idea sees the planning and direction of research as a logical process proceeding by obvious stages from point to point to a predetermined goal after an expenditure of time and money calculated in advance by accountants. It is unfortunately nothing of the kind.

Inspiration comes only to rare individuals; it floats up intuitively from the subconscious. It is communicable from a leader to a team only if the members have confidence in him both as a man and as a scientist.

As the chart of the unknown becomes filled in, judgment of the most profitable course to follow itself changes.

If we wish to plan research we can only do so by assembling a community of people with mutually complementary talents, operating with strategic flexibility and in an atmosphere of curiosity in which the members know and understand what the others are talking about and respect their leaders.

We must remember the words of Newton who when once asked how he made his discoveries said 'By always thinking into them'".

No committee structure, however logical and tidy, will replace the devotion of which Newton speaks.

Dr. Selye made several points that were closely related to those of Sir Cyril in his testimony before the Committee and with which we are completely in agreement, viz:

(a) past successes are the key to likely future performance

(b) only one very outstanding master in a school is needed to attract students and assistants

(c) great discoveries are due to accident but you have to have a mind prepared to profit from accident

The technological gap between research and development achievements and practical application is in many cases increased by the complexities of modern plan. Rose (46) discusses the tendency towards increasing automation of chemical process plants and concludes that specialized process control engineers are needed with qualifications that he enumerates. We mention this fact because lack of such personnel has frequently been a hindrance to effective plant application of new ideas.

In their discussion Bradbury et al point out the following facts relating to the putting to work of new concepts. Whilst their ideas are based upon the chemical industry, the underlying principles are of wider application.

(a) The futility of the old procedure of giving a chemist a process to work out and having him write it up and hand it over to a chemical engineer.

(b) It is necessary to work from the outset in teams - chemists, chemical engineers, mathematicians, metallurgists, physicists - working on the basis of systems analysis.

(c) Process development must be put into its business contact by adding an economic dimension - the objective in process development is to generate the technology on the basis of which manufacturing plan can be constructed and operated properly. The technical and economic aspect of process development are inextricably intertwined.

(d) The business of research is uncertainty reduction. Research is too expensive to spend long on processes that are abandoned for weaknesses which might have been foreseen.

(e) Any unnecessary commitment to a process development project means lost opportunity elsewhere. The objective in the process discovery stage is to find the most appropriate process in which to invest the research and engineering resources that will be required to create a full scale working plant.

(f) The process must be understood ...... "such understanding as there is on operating plants is often buried beneath an accretion of mythology and emotional reaction". Two areas of understanding exist:

(i) Specific to a particular plant.

(ii) The understanding that links the specific and unique example of scientific laws that is the plant to the generality of science.

Once any problem is fully understood, scale up problems vanish. The engineer carrying the responsibility for the design of the full scale plant, should design the semi-technical plant.

<u>We conclude that further emphasis should be given in Canada to systems engineering.</u> The emphasis should not be to put computers in and think out what to do with them afterwards, but should be process analysis as defined in Reference (47) followed by the application of the most appropriate control to the process. Our views of systems engineering are summarized in References (48), (49), (50).

In the discussion above, we have dealt with one of the technical causes for difficulty and lapses in the application of new technology. We have not, however, considered the psychological barriers to the adaption of new ideas as this is at the edge of our competence. We would, however, be glad to discuss them orally.

6. Market Research

The rules of operating an industrial economy are often more honoured in the breach than the observance. One of these rules is the carrying out of adequate market research. That the economic and technical aspects of development are inextricably intertwined was pointed out in Section 5. Adequate market research is vital to the introduction of a new product or the change of an existing one. References (51) and (52) provide a background on this little understood activity.

Our observation of Canadian industry leads us to believe that market research is often inadequate, particularly in smaller companies. Improvement in the technique of market research employed would, we consider, make failures in the introduction of a new product or commissioning of a new plant less frequent; the decreasing uncertainty would remove one of the barriers to the introduction of new ideas.

Measures to improve the teaching and application of market research in Canada would, we consider, benefit the economy and should be considered in constructing a science policy for Canada.

Use of the Literature

Lord Rayleigh once said "By a fiction as remarkable as any to be found in law, what has once been published (not matter what the language) is usually spoken of as known, and it is often forgotten that the rediscovery in the library may be a more difficult and uncertain process than the first discovery in the laboratory.

It is sometimes difficult to discover the existence of pertinent references and, of course, may be almost impossible unless an adequate library is available. Nevertheless it is our impression that the major difficulty in this regard faced by technical workers is not the problem of discovering the reference, but that of either knowing how or of summoning up the energy to try. There seems to be a tendency in many industries to rediscover the wheel about every ten to fourteen years. This is certainly true in the pulp and paper industry and we are told, is also true of the pulp and paper machinery manufacturing industry. When earlier work is repeated with a knowledge of the earlier work done, additional information is frequently obtained as a result of changed circumstances and improved techniques. Repetition of earlier work by ignorance, on the other hand, frequently produces work and information inferior to that in the original publications.

The periodicity of this cycle appears due to the progression of experienced men from the sphere of active work. Those who take their place have no knowledge of what has been done and neglecting to find out, repeat it as the circumstances which prompted the original work.

Reading and searching the literature are subjects not often taught in universities. Attention to the spreading of the appropriate techniques would ultimately have a profound effect in Canada.

It is not often pointed out that the internal technical reports of a company constitute a most valuable source of reference and are, in fact, a part of the literature. Many of the technical organizations in any country will be found to have a filing system that is designed to put things neatly away, rather than get them out easily. Teaching the elements of technical filing, though not glamorous, would contribute to the efficient use of science and technology.

The government or public library services available in Canada appear generally adequate. We do not have knowledge of the state of company libraries and suggest that this be surveyed. It would seem to us that there is room for the improvement of "in company" libraries and information systems and that there should be a place in Canadian industry for more trained librarians and information specialists.

Whenever the subject of library and information services are raised, someone always suggests that computerization is the answer. This suggestion should be treated with care. We believe that a computer can make an efficient library and information more accessible, but cannot improve an inadequate or almost non-existent system.

Without an adequate information system the work of the scientific community cannot be adequately utilized and will, in fact, fail to reach its possible pace.

At this point we may bring up the question of monographs. During a lecture tour of the U.S.S.R. ten years ago, one of us was told by a Cabinet Minister that the Soviet Government attached great import to monographs as they would be read by few but those who did read them were the very men who would improve the economy of the country by their actions and decisions. Every incentive was therefore, provided by the Soviet Government for the production of monographs of real merit. Mr. Curtis G. Benjamin, retired President and Chairman of McGraw-Hill Book Company, has pointed out* that such works could soon be priced out of commercial book markets.

We believe that support of monographs would aid the development of science and technology in Canada and suggest that consideration be given to including it in as future policy for science in our country.

There is another method to spread what is known and promote its use allied to the monograph. This would be the holding or giving of a government-sponsored series of lectures (adequately stipended and permitting the charging of expenses in the gathering of data) on selected aspects of industrial technology.

It is suggested that the lectures should be made prestigious so that men of the necessary repute will feel honoured to give them. They could be tied in with existing technical organizations and would perhaps be given at their annual meetings. In large and diverse industries they could at first perhaps be annual, each year a different aspect of the industry being considered, e.g. pulp and paper, mining, chemicals, petroleum, electronics.

For smaller industries the number could be "floating", the giving of the lecture being dependent upon the emergence of a suitable lecturer. The theme of the lectures would not be "what the future holds" or what will he be doing in the future, but rather "are you doing this now" based on the knowledge freely available.

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* Reported in Graphic Arts Abstracts November 12, 1968, from Scientific Research

8. The Wider Aspects
The Interconnection of Science and Public Affairs

It is vital that our legislators, as well as the specialist committees which serve them, have access to science of the day. It would be impertinent to do anymore than suggest for consideration those magazines which we have ourselves found of the greatest utility in keeping us informed about scientific matters outside our special competencies and concerning the interrelationship of science and society.

These are:

(a) The New Scientist

A journal published in the United Kingdom, but effectively international in scope, giving good coverage of scientific affairs at an easily understood level.

(b) Chemistry and Industry

The magazine of the Society of Chemical Industry. Whilst centered in the United Kingdom, this Society has a large U.S. section and sections in many other parts of the English-speaking world, including Canada.

The essay reviews are of particular value.

(c) Bulletin of the Atomic Scientists

In spite of its name, this is the premier journal of science and public affairs in the English-speaking world.

The New Scientist; several articles have been quoted from this publication in the present brief. Typical of the individual pieces of information likely to be of value is the news item "signs that the atmosphere is getting dustier" (17th October 1968). Sufficient articles from Chemistry and Industry have already been noted in the brief to indicate its value. The Annual Meeting of the Society of Chemical Industry will take place in Montreal in 1969.

Articles of import in the widest aspect of the committees work that have appeared in the Bulletin of the Atomic Scientist include the following:

(a) Man and His Habitat: Problems of Water Pollution
April 1965, Pages 16-22

(i) Cleaning Up the Merrimack by Leonard Wolf
(ii) A Hard Look at Soft Detergents by Cooper H. Waymar

(b) Man and His Habitat: Problems of Water Pollution
May 1965, Pages 2-11

(i) New Directions in Water Management
by Allen V. Kneese
(ii) Nawapa: Water for the Year 2000 by Richard S. Lewis

(c) Science in the State Department by James R. Killiam, Jr.
May 1965, Pages 12-17

(d) Man and His Habitat: The Pollution Air
June 1965, Pages 6-25

(i) For Air Conservation by James P. Dixon
(ii) What Pollution Costs by S. Smith Griswold
(iii) In Polk and Hillsborough Counties, Florida
by Thomas D. Crocker
(iv) Applying Economic Controls by Mason Gaffney

(e) Synthetic Food for Tomorrow's Billions by Archibald T. McPherson
September 1965, Pages 6-11

(f) Allocating Federal Support for Basic Research by Carl Kaysen
January 1966, Pages 16-22

(g) Allocating Support for Basic Research - And the Importance
of Practical Applications by G. B. Kistiakowsky
February 1966, Pages 12-18

(h) The Role of Applied Science by Edward Teller
March 1966, Pages 15-19

(i) Nawapa: A Continental Water System
September 1967, Pages 9-27

(j) Nawapa: A Wet Exchange,
September 1968, Pages 35-37
(Letter on original series of articles with rejoinder)

(k) Common Opponent Sought and Found? by Ernst Haas
November 1968, Pages 8-11

(l) Modern Physicist and the Case for Science Politics
by L. A. Artsumovitch
November 1968, Pages 23; 41-48

(m) Science and the Human Condition
October 1968, Pages 23-43

(n) The Vanishing Plant Breeder: Who Will Expand Our Food Supply
by Sherret S. Chase
December 1968, Pages 10-13

(o) Science for Man the Deveopment Gap by J. Leites Lopes
December 1968, Pages 14-17

These wider aspects of science and society, both our own and those of our associates, must be considered in formulating a science policy for Canada. We are not able to suggest a mechanism other than to endeavour to assist those who will formulate the policy on the one hand and implement it on the other to keep themselves informed.

9. Women

When one of us returned in 1959 from a lecture tour in, and examination of the educational system of, the Soviet Union, and was asked what had impressed him most, he replied "the fact that women were truly treated as the equals of men".

In our country, as in the U.S., we really only pay lip service to the idea of equality of the sexes. How many female engineers graduate yearly and how easy is it for them to find positions in which they can be real engineers? Whilst more female scientists qualify, the numbers are still small and the jobs they hold are restricted.

We suggest that in developing a Science Policy for Canada, consideration be given to developing the latent brainpower in our women that is not being presently utilized.

10. Concluding Section

In preparing the foregoing brief we have also considered the statement by the Honourable Chairman of the Committee in the Senate, Tuesday, September 17, a speech on "The Development of Research in Canada" by the late E.W.R. Steacie (53). Dean Mardell appears to us to be sharpening the academic axe in his article and we do not see why research is necessarily better for being carried out in a university rather than in a government laboratory. Indeed from such limited references as we have had of both in Canada, we would consider the efficient prosecution of research at the NRC laboratories or at Atomic Energy of Canada much more likely than in most universities.

When Dean Mardell comments that the government has not spent nearly enough on research, he is ignoring the fact that good research centers cannot be fashioned overnight, but must be built up slowly and carefully "and that experienced research directors and Management are already in short supply" (56) and again that "for an entirely new project the difficulty is to attract the one or two key research workers needed to make a beginning" (57). We have found that progress in R and D is dependent on the few key individuals referred to by Dr. Gray and, thus, any attempt to speed up research on a national scale, as apparently suggested by Dean Mardell, by the spending of large sums of money is likely to result in wasted money and poor work. It seems to us that the task is to create more productive research workers with the creative touch by developing those who have this talent in latent form and to create a more informed managerial sector who can use the results when they are available if they are economically justified in so doing. For both of these we require the right type of graduate from our universities and this in turn takes us down to the school system.

We have avoided indicating how the resources available should be deployed for the good of the nation. We would not quarrel with the ideas put forward by Dr. Solandt (55), though we would with some of his testimoney to the Committee.

We are, however, in favour of the idea of using some part of the funds available to develop "Centres of Excellence" in subjects of study, particularly appropriate to Canada as was suggested by Dr. J.L. Gray (58) and earlier by Dr. Haas Selye (59) when he said "if we do develop a strong Canadian scientific policy, we should try to achieve not mediocrity in many areas but excellence in a few".

It appears to us suitable to close this brief with another quotation from Dr. Selye when he said (50) "No matter how you look at progress in other fields the disadvantages of science have been colossal ..... the development of what we call a civilization always has destroyed something in nature. It also takes away certain inherent values of life, perhaps by substituting more efficient, but in a way, cheaper and more mechanized values."

Our comment is that when something in nature is destroyed, it may not be possible to restore it; in developing our science policy we would, therefore, urge an attitude of conservation. Our aim should, we believe, be the minimizing of the disadvantages of science as well as the maximizing of the advantages.

REFERENCES

1. Proceedings of the Special Committee on Science Policy
No. 8, November 1968, Page 957

2. Lees Clifford
Patent Protection - The Inventor and His Patent
Business Publications Ltd., London, 1965

3. MacRae, A. E.
Inventions and Patents in Canadian Practise
Canada Law Book Company, 1954

4. Jucker, E.
The Development of the Swiss Pharmaceutical Industry and Its Contribution to Therapy
Chemistry and Industry, No. 48, November 30, 1968
Pages 1659-1665

5. Annytage, W. H. G.
Four Hundred Years of English Education
Cambridge University Press

6. Rickover, H. G.
Education and Freedom
Dutton, 1959

7. Rickover, H. G.
Swiss Schools and Ours - Why Theirs Are Better

8. Rickover, H. G.
Report on Russia

9. Bereday, G. Z. F.; Brickman, W. W.; Read, G. H.
The Changing Soviet School
Houghton Mifflin Co., 1960

10. Timoshenko, S.
Engineering Education in the Soviet Union
McGraw-Hill

11. Mardon, J.
A Comparison Between the U.S. and Several European Educational Systems
A lecture delivered in various places in the U.S.A.
1961, 1963

12. Hammersley, J. M.
On the Enfeeblement of Mathematical Skills by 'Modern Mathematics' and by Similar Soft Intellectual Trash in Schools and Universities
Bulletin of Institute of Mathematics 4;4;66-85
(October 1968)

13. Enquiry into the Flow of Candidates in Science and Technology into Higher Education
HMSO 1968 (Commonly referred to as "the Dainton Report")

14. The Flow into Employment of Scientists, Engineers and Technologists
HMSO 1968 (Commonly referred to as "The Swann Report")

15. The Employment of Highly Specialized Graduates
Science Policy Studies No. 3 HMSO 1968

16. Proceedings of the Standing Committee on Science Policy
1968, No. 5; Page 649, Item 13 (Dr. J. L. Gray)

17. IBID
No. 8; Page 958 (Senator Mackenzie)

18. Mardon, J.
The PhD in Industry
Lecture delivered at U.B.C., Spring 1966

19. Chemistry in Britain
4; No. 11 (November 1968) Editorial

20. Davies, D. S.
Pragmatism in the Scientific Manpower Field: the Swann Report
Chemistry and Industry, No. 39; 1309-1312 (September 28, 1968)

21. Education in Britain (C10 Ref. pamphlet No. 7)
HMSO 1967

22. Higher Education (Report of Committee on Higher Education, Commonly Called the Robbins Report)
HMSO 1963

23. Half Our Future (Report of the Central Advisory Council for Education (England))
HMSO 1963

24. Children and Their Primary School (Report of the Central Advisory Council for Education (England))
HMSO 1967

25. Mardon, J.
The Organization, Direction and Detailed Mechanics of Research Management
Lecture to Engineering Institute of Canada
(October 1968)

26. Mardon, J.
The Training of New Intake Engineers for the Pulp and Paper Industry
Pulp & Paper Magazine of Canada 66;12;90-103 (December 1965)

27. McCarthy, M. C.
Education for a Ratless Society - 4 The Scourge of Specialization
New Scientist October 10, 1968; p. 88, 89

28. Proceedings Standing Committee on Science Policy
No. 5; P. 678 (Dr. J. L. Gray) (October 30, 1968

29. Proceedings Special Committee on Science Policy
No. 9; p. 174 (Dr. C. Wright) April 17, 1968

30. Proceedings Special Committee on Science Policy
No. 1; p. 18, 19 (Senator Mackenzie and Mr. Boucher)

31. Proceedings Standing Committee on Science Policy
No. 5; p. 678 (Dr. W. B. Lewis) October 30/31, 1968

32. Discussions with Sir G. I. Taylor, F.R.S. 1954-1968

33. Mardon, J.; Cripps, W. C.; and Mathews, G. T.
The Further Education of Practising Engineers
Paper presented Annual Meeting, C.P.P.A., Montreal January 1969

34. Proceedings Special Committee on Science Policy
No. 10; p. 202 (Dr. Selye) April 17, 1968

35. Davies, D. S.
Education for a Restless Society 3 - "Club Sandwiches" for Scientists
New Scientist; Vol. 40; No. 617; p. 31-32 (October 3, 1968)

36. UKAC Record, No. 9, March 1968
Investing in Technicians
Education and Training Needs for Progress in Automation and Technology

37. Kursanov, A. L.
Some Problems in the Training of Young Scientists
Akadamia Nauk SSSR Vestnik Vol. 29; No. 3; 36 (1959)

38. Mardon, J.; Mardon. L. D.
The Principles and Detailed Mechanics of Research Direction and Management
National Business Publications 1968

39. Collinson, H. A.
Management for Research and Development
Pitman 1964

40. Lothrup, W. C.
Management Uses of Research and Development
Harper and Row 1964

41. Bass, L. W.
The Management of Technical Programs
Praeger 1965

42. Mitchell, J. W.
The Organization of Basic Research for the British Chemical Industry
Chemistry and Industry; p. 908-935 (May 29, 1965)

43. Dux, E. F. W.
Personal Problems in an R and D System
Chemistry in Britain; Vol. 4; No. 9; 393-395 (September 1968)

44. Institution of Chemical Engineers, Landon
Proceedings of the Symposium on Productivity in Research
December 1963

45. Hinshelwood, Sir Cyril
New Scientist (September 2, 1965)

46. Rose, S. P.
Developing Technologists for Tomorrow Process Plants
Chemistry and Industry; p. 4-6 (January 1, 1966)

47. Bradbury, F. R.; Rose, L. M.; Suckling, C. W.
Trends in Process Development
Chemistry in Britain 4; No. 11; 489-499 (November 1968)

48. Mardon, J.
Computer Application is More Than Buying Electronic Equipment
Paper Trade Journal 151; 18; 35-7 (May 1, 1967)

49. Mardon, J.; Cripps, W. C.
Selection and In House Development of Systems Engineers
Training and Development Journal; Vol. 21; No. 9; 87-98 (September 1967)

50. Mardon, J.; Barrett, J.E.; Chamberlain, R.E.
The Place of Systems Engineering in the Process Industries
Norsk Skogindustri 21;11;456-61 (November 1967)

51. Stacey, N. A. H.; Wilson, A.
Industrial Marketing Research
Hutchinson 1963

52. OECD Paris
Technological Forecasting in Perspective 1967

53. Steacie, E. W. R.
The Development of Research in Canada
Speech at the Opening of Laboratory Addition Imperial Oil Limited, Sarnia, Ontario (January 22, 1962)

54. Mardell, D. L.
Basic Changes Needed in Research Policy
Canadian Business p. 48-54 (April 1968)

55. Solendt, O. M.
A Science Plan for Canada
Canadian Business p. 68-73 (May 1968)

56. Proceedings of the Standing Committee on Science Policy
No. 5; p. 652- Sect. 35 (Dr. J. L. Gray) October 30, 1968

57. IBID
Dr. J. L. Gray, p. 795

58. IBID
Dr. J. L. Gray p. 653, Section 30

59. Proceedings of the Special Committee on Science Policy
No. 10; p. 188 (Dr. Hans Selye)

APPENDIX I

TABULATION OF SIGNIFICANT POINTS FROM PREVIOUS SUBMISSION TO THE SPECIAL COMMITTEE ON SCIENCE POLICY

This Appendix is effectively an alphabetical index of the important points so far raised in the committee's hearing. The authors of this brief have reviewed in detail all submissions made to the Senate Committee up to #12, Wednesday, 27 November, 1968.

Detailed tabulation in Senate Master Copy only.

ITEM	REF.	SPEAKER	AUTHORS COMMENTS
Ability - There is no relationship between ability of a person to get a grant and his ability to solve a scientific problem.	No.10 Apr.17.68 P.171	Dr.H.Selye	We agree.
Accidental Discoveries - "Great Discoveries are due to accident, but you have to have a mind prepared to profit from accident".	No.10 Apr.17.68 P.199	Dr.H.Selye	Agreed
Acceptability of the Calibre of Research - A criterion is International acceptability.	No.6 Mar.20.68 P.119	Prof.Porter	Agreed
Adjust Programs by changes in recruitment pattern. (Agric.) e.g. - Replacing economic entomologists with pesticide chemists.	No.10 No.21.68 P.1052	Mr.S.Williams	A suitable method for large organizations.
Aeronautical R & D (G.B.) amounts 35% of output.	No.5 Mar.19.68 P.97	Prof.Blackett	In any country where a large part of the R & D is spent on the Armed Forces, a very high percentage is spent by the Aeronautical Industry but is effectively paid for by the Government.
Age - Influence of - ? No great work after 30.? Not a relevant factor	No.1 Mar.12.68 P.18 - 19	Sen.Mackenzie queried these statements. Mr.Boucher	It is our opinion that the majority of those who fail to produce as they get older have depended from the outset on other people for their creative ideas. A truly creative man will produce as long as his health allows. e.g. Sir Christopher Wren, - Sir G.I. Taylor.

(2)

Age: Problem in Defense Research - best work in science and research is by and large done by younger men and women - "	No.4 Oct.24.68 P.285.	Sen.Mackenzie.	See P. (1) for comments.
Allocation of funds - "You judge by past accomplishments."	No.10 Apr.17.68 P.192	Dr.H.Selye	We absolutely agree but this fact is nearly always ignored by "Professional" managers.
Alternative to war - "try to devise a peaceful alternative to war as a source of technological advance"	No.4 Mar.13.68 P.74	Prof.Bladen	The alternative must be constructive. Alternatives such as the building of the Pyramids, the Roman Circus or the "Space Race" can destroy civilization. We suggest irrigating the desert and planting trees.
Applied science - lack of development - in Industrial &D.	No.3 Oct.23.68 P.42	Dr.Schneider	Perfectly true but one cannot develop industrial R&D faster than the necessary gifted individuals become available.
Arctic - Need for research on	No.6. Mar.20.68 P.119	Prof.Porter	We agree that the Arctic & Oceanography are vital areas. Our informants in Alaska consider Canada behind the U.S. in the field of Arctic investigations.
Attrition - If the portability of pension plans between DRB, industry & Universities were satisfactory, then older scientists from DRB might be found useful employment. This would provide satisfactory attrition in DRB.	No.14 Oct.24.68 P.276 P.281	Dr.Uffen " "	Industrial R&D could use some of these men. We agree with this idea, which should be extended throughout the scientific community.
Awareness - lack of wareness by scientists of the significance of science in the present world.	No.2 Oct.9.68 P.19	Dr.J.Spaey	Disagree that this is so with men of real capability.

Belgian - Legislation & industrial research	No.2 Oct.9.68 P.26	Dr.J.Spaey	We agree with the Belgian view that "foreign" firms should set up their own R&D in other countries in which they are operating.
Responsibilities of Minister of Science Policy	P.27	" "	
Universities' Budget.	P.24	" "	
Bridge - Between the input of science and political policy making.	No.3 Oct.23.68 P.49	Sen.Grosart	As we see it, to produce a recommendation on this point is one of the principal tasks of the committee. This can only be done through people and will necessitate understanding of science by politicians and participation in the political process by scientific generalists.
Canadian agricultural R&D in 1966. 1.9% of Gross Farm product. Compared with 1.33% for total R&D of G.N.P.	No.10 Nov.21.68 P.1097	Agric. Report.	As an agricultural country, Canada should have a high expenditure R&D rate in agriculture. This is a scientific "export" which Canada can contribute to other countries.
Canadian Dept.Agric. has own departmental services i.e. Management Consulting.	No.10	"	We favour development of "internal" management consulting expertise both in Government & Industry.
Centralized vs. Decentralized planning.	No.14 Apr.25.68 P.273 P.274	Dr.King	The total direction should be centrally planned, but details should be left to the specialists. The central direction is effectively a management problem.

Changes that have occurred in science makes it very difficult for many people to keep up.	No.10 Nov.21.68 P.1083	Dr.Migicovsky	We agree, but people Must keep up, or a large part of the country's mental resources will be wasted. In our brief we have suggested methods of "Keeping Up"
Channelling of basic research - "A wise administration does not attempt to direct closely or to channel basic research while it is in progress"	No.3 Oct.23.68 P.98	N.R.C. Support to Brief.	Supervision is essential. Furthermore supervisory management must maintain its scientific capability & judgment for effective direction of effort.
Classic innovation chain - in R & D. applied work, invention, development, prototype design and construction, production, marketing, sales and profit.	No.5 Mar.19.68 P.92	Prof.Blackett	A clear description with which we agree.
We are canalizing more and more of our interests towards the latest stages of the innovation chain!	No.5 Mar.19.68 P.93	" "	Whilst we should learn from the British experience case histories of developments should be studied rather than just applying the final British conclusions. Canada is industrially a smaller country & the problems will be relatively more severe.
Closing the gap between knowledge and practice - is promoted by associating scientists with problems where they occur.	No.10 Nov.21.68 P.1051	Mr.S.Williams	We agree
Competence in Canada - "What was of primary importance was to have in Canada a competence to take advantage of what was available to us"	No.1 Oct.9.68 P.6	Mr.Mackenzie	Good Point. This applies to several industries.

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Competence - outstanding research and admin. competence is a rare combination.	No.10 Nov.21.68 P.1158	Agric. Report	This fundamental point is ignored by almost everyone.
Computer science and technology, considered as suitable area for major program.	No.3. Mar.13.68 P.53	Dr.Solandt	See also Science Council Report #4,Pg.43. Care is however, needed. Many expensive errors have been made in industry: (a) by systems analysts who did not understand the part of the business to which they were applying the computer. (b) by systems engineers who impose the computer on top of a process & hope for the best rather than thoroughly investigating the process and its dynamics & then designing more effective control.
Continual review & Planning "processes allow priorities to be determined - review processes eliminate as much as possible any sudden need to terminate a project which has already advanced -"	No.5 Oct.30.68 P.794	Atomic Energy Submission	The proper approach. We were impressed by the whole AECL brief.
Continuing technical audit - benefits of.	No.11 Nov.26.68 P.1259	Sen.Grosart	See Comment Above
Controller of Industrial Technology (U.K.). Distinguished applied Scientist	No.5 Mar.19.68 P.91	Prof.Blackett	This approach is most sensible, but should be considered with Administrative costs in mind. The Canadian effort is perhaps 1/5 that of the U.K.

(6)

Co-operative Research - ncourage this on an Industrial basis.	No.4 Mar.13.68 P.82	Chairman (M.Lamontagne)	Between us, we have had considerable experience of cooperative research organizations in many different countries. They rarely reach even 50% of their potential. Too often the organization is properly staffed but not supported by industry, or is too politically oriented and its program reduces to short term ends which should properly be done by industry.
Creativity & Its Support Support the creative people who are available "to get advances and development of scientific strength that one needs"	No.11 Apr.18.68 P.215	Dr.J.Killian	We agree. Too often the creative man is discouraged because he does not have an "ordinary" personality.
Curiosity directed Research. Britain spends 0.3% of NP	No.5 Mar.17.68 P.90	Prof.Blackett	Some must be done in all countries. Prof. Blackett's comments "within the budget which a nation provides for basic science, the scientists should collectively manage their own affairs" We agree.
Cut and dried Solutions - Must be avoided. (entrusting the organization for State Science policy to managers or men of science).	No.2 Oct.9.68 P.20	Dr.J.Spaey	We agree. The problems are managerial, although they may need scientific knowledge to solve them.
Danger of league-table approach in estimation of amount of GNP that should be spent on research.	No.10 Nov.21.68 P.1107	Agric. Report.	We agree.
Defence Research Board - Average age of scientists.	No.4 Oct.24.68 P.276	Dr.Uffen	See comment under "Attrition"

Definition of industrial research for government aid. "there definitions fail to accomplish their real objective"	No.1 Oct.9.68 P.3	Mr.Mackenzie	We agree
Difficulty to attract one or two key workers required to make a beginning.	No.5 Oct.30.68 P.795.	App. 12	This is the key point in organizing any R&D work.
Education & science big unbalance will occur - unless educational systems are geared to industrial development and the possibilities of technology.	No.14 Apr.25.68 P.277	Dr.King	Our view is that the educational system must be considered when formulating a science policy.
Education policy - Part of overall science policy.	No.13 Apr.24.68 P.256	Dr.Nelson	See comment above.
Efficiency improvement. "bring average efficiency up to the level of the best available practice.	No.4 Mar.13.68 P.76	Prof.Bladen	This should be one of the targets of Canadian Science Policy.
Employ Scientific & Engineering manpower in field for which they are trained. --How to do this?	No.5 Oct.30.68 P.652.	Dr.Gray	We agree with Dr. Gray that too little attention is being given to this point.
Excellence -"it is essential that there be a few centres of superlative excellence"	No.11 Apr.18.68 P.218	Dr.Killian	We agree - Vide - the success story of U.S. electronics research centered around MIT & Stanford.
Exchange of information with other countries.	No.3 Oct.23.68 P.57	Dr.Schneider	This is a basic point in R&D Management.
Expenditure in Pure Science.	No.3 Oct.23.68 P.41	Sen.Lang	Sen. Lang's points are sound. However, (1) Purchase of technology will only go so far. Intensive subsequent R&D is still necessary. Vide Japanese electronics & optics industries.

			(2) Effective basic research is needed. (a) for training, and (b) for assimilation of existing technology.
Experienced Research direction & management are already in short supply.	No.5 Oct.30.68 P.653	Dr.Gray	We agree. Must be taken into account as a limiting factor in expansion of Canadian science.
"Facilities required to train engineers for management & for the kinds of engineering that are going to be done in Canada" -- More required.	No.8 Nov.6.68 P.985	Dr. Solandt	We agree 100% with this statement.
Faith in charting course in basic research of creative individuals. "One has to take their capacity to chart their course on faith as being sound one"	No.11 Apr.18.68 P.216	Dr.Killian	We agree, but see our comments under "Channeling of Basic Research"
Financial aid to research on industrial side not sufficient?	No.3 Oct.23.68 P.46	Sen.Bourget	Not the amount so much as the method.
Find out why things are not opening up faster in industries.	No.3 Oct.23.68 P.40	Dr.Schneider	Industrial technology is proceeding at too slow a rate. See brief for suggestions.
Finding alternative use for a laboratory -- would be needed if DRB funds not expanded to keep pace with inflation.	No.4 Oct.24.68 P.301	Dr.Uffen	A good idea. Why don't we do this?
Formal project system Believed to be best & most mature & most sophisticated in the world.	No.10 Nov.21. P.1052.	Mr.Williams (Agric.)	If it is as good as claimed - we should get details.
Fragmentation of our industry brought about ·rtly by foreign ownership.	No.3 Mar.13.68 P.51	Dr.Solandt	As noted above, foreign companies should do R&D in Canada.

(9)

Freshwater resources ı Canada - need for study.	No.8 Nov.6.68 P.956	Sen.Mackenzie	We strongly agree. A vital Canadian resource
Frivolous research - chance in Industry very small indeed but Great deal of research effort comes to a dead-end and can be regarded as wasted.	No.1 Oct.9.68 P.5	Mr. Mackenzie	We believe that there is frivolous research in industry, due to poor project selection.
Fundamental work - people knowing how & what to do should be given adequate funds and left alone to work out their own Science policy.	No.2 Mar.12.68 P.32	Dr.C.Mackenzie	We agree. See under remarks "Channeling of Research
Funds - raising of - Waste of time.	No.10 Apr.17.68 P.189	Dr.H. Selye	We agree. Gifted scientists should not be required to waste their time in such activities.
Funds - committee should ıke a recommendation to ıhe Govt. as to % GNP to be put to R&D	No.1 Oct.9.68 P.16	Sen.Grosart	Efficient R&D expenditure is controlled by skilled people available This will limit effective effort, probably below any % of GNP which would be allocated.
Support funds - must be available on a continuous basis. The least overall cost to taxpayer is by business income tax incentives.	No.1 Oct.9.68 P.5	Mr. Mackenzie	We agree.
Good research & Development done in the right fields as efficiently as possible by the best people -- should be the aim.	No.5 Oct.30.68 P.651.	Dr. Gray	We Agree.
Good R & D centres cannot be built overnight - create them by building slowly and carefully.	No.5 Oct.30.68 P.652	"	As noted in other sections, this will be the limiting factor in Canadian expansion.
overnment - contribution to stimulate general industrial R&D effort should improve general climate rather than individual projects.	No.1 Oct.9.68 P.4	Mr. Mackenzie	We agree.

(10)

Government - assistance - s it really necessary. Will not the return from R&D be a sufficient inducement?	No.1 Oct.9.68 P.4	Mr. Mackenzie	Justification solely on a financial basis leads to things that are not worthwhile being done.
Government - change of role from being an agency that does to being an agency which fosters, stimulates and guides research	No.3 Mar.13.68 P.52	Dr.Solandt	Care must be taken not to impair the resources now existing in government laboratories for purely doctrinaire reasons.
Government - how does it help private firms to be efficient - have high innovation rate, be up to date, have good management - high productivity and high exports within the free enterprise system?	No.5 Mar.19.68 P.91	Prof.Blackett (U.K.)	This is one of the two key questions (the other is the allocation of priorities.
Government limit in Belgium - never pay over 80% of the cost of esearch.	No.2 Oct.9.68 P.23	Dr.J.Spaey	A sound policy.
Government support of research not to be confused with welfare.	No.2 Oct.9.68 P.23	"	We heartily agree.
Government support to industry - industries must take some initiative to implement programmes they feel are important to their future and to support them technically.	No.5 Oct.30.68 P.674	Sen.Aird	We agree that their comments highlight one of the vital points of policy.
Industry must participate from top management down.	"	Dr. Gray	
Graduate competition for jobs - for the first time there might be some competition - which may not be a bad thing.	No.3 Oct.23.68 P.40	Dr.Schneider	We agree, and look forward to this!
Grant increase - it is xtremely risky to increase any grants too rapidly.	No.2 Oct.9.68 P.25	Dr. Spaey	We agree, because of dependence of success on available skilled personnel

Graduate orientation - to-day's graduate too strongly academically oriented and not interested in industrial research -	No.3 Oct.23.68 P.34	Dr.Schneider	This is true and we discuss this in the brief.
Guidelines - as to how best to utilize moneys available & direct them into the channels which will be the most productive for the national interest.	No.13 Apr.24.68 P.259	Sen.Carter	This seems to us to be a definition of what the committee is looking for.
Identification of creative and effective workers - strong reliance must be placed on personal judgment. Basic criteria for judgments are quality and value of work done, individual drive, initiative and the ability to communicate.	No.5 Oct.30.68 P.750,751	Appendix 8	We agree. A succint definition.
Importance of fundamental research - it produces the people who will put science into effect as managers of technical processes, as innovators etc.	No.14 Apr.25.68 P.274.	Dr. King	This is true, but it must not be a vehicle for passengers rather than drivers.
Imported and second-hand technology - if you hope to live on this - you are always going to be well behind.	No.3 Oct.23.68 P.42.	Dr.Schneider	Countries are like companies in this regard.
Improving quality of life - "let us be as concerned with the possibility of improving the quality of life as we are with increasing the quantity of material goods."	No.4 Mar.13.68 P.74	Prof. Bladen	We Agree.
Increase financial support by from 10-12% p.a. - to maintain the extablished level of activity (Agric.)	No.10 Nov.21.68 P.1053.	Mr.S.William	This should be reviewed periodically. Maintenance of a given annual expenditure over say 2-3 years would compel an internal audit of work in progress.

Increases would need to be very large (Agric - R&D) - before they would exceed the incremental benefits.	No.10 Nov.21.68 P.1151	Agric. Report.	We Agree. See note against Can. Agric. R&D
Industrial Reorganization Corporation (U.K.)	No.5 Mar.19.68 P.92	Prof.Blackett	Something like this may well be necessary also for Canada.
Industrial laboratories - Opportunities that will attract highly gifted & creative scientists and engineers will be started by new technology. The presence of these men in the industrial environment will greatly stimulate innovation generally.	No.3 Oct.23.68 P.38	Dr.Schneider	We Agree.
Industrial R&D effort has concentrated for the most part on short-range programs likely to produce a more immediate return.	"	"	The observation is correct. Only large companies can afford long range R&D, and success in these is entirely dependent on creative & gifted workers.
Industrial sector - has not achieved a sufficient rooting of R&D	"	"	We agree. This is a management problem.
Information - how to deal with flow of scientific & technical information.	No.11 Apr.18.68 P.210	Mr.Killian	While Mr. Killian is right, we in Canada have an even more basic problem - that of using the information that is easily available. See brief for suggestions.
In-House research - "I do not agree with the Science Council that in-house research has to be reduced - but I do agree that we have to increase the activities at Universities in order to produce the type of people that in-house requires"	No.10 Nov.21.68 P.1086	Dr.Migicovsky	We agree in principle. Care must be taken not to over-support the Universities, which are now striving for the privileged position enjoyed in the Middle Ages by the Church.

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Innovation - What we are concerned with is the process of innovation - not merely R&D	No.3 Mar.13.68 P.52	Dr.Solandt.	True.
Innovation stems from science, particularly scientific research.	No.2 Oct.9.68	Dr.Spaey	Also True.
Lack of Interest by companies is a deterrent to full support by the Govt.	No.5 Oct.30.68 P.651	Dr.L.Gray	Proper industry reaction necessitates fuller management understanding of R&D, benefits, costs and chances.
Library Computerization Not necessary	No.10 Apr.17.68 P.197	Dr.Selye	No advantage is gained by computerization per se. To be effective the following situation must exist. (a) A well organized & thoroughly effective library. (b) A sufficient body of people already using the library efficiently. If these conditions exist, computerization will enable the scope & usage of a library to be extended. If the original group of users does not exist, Computerization will not produce them.
Link between industry & the university is still extremely small.	No.3 Oct.23.68 P.65	Prof.Bonneau	We agree & have tried in our brief to indicate how this can be improved.
Linking science policy and education.	No.2 Oct.9.68 P.20 - 21	Dr.Spaey	This should be done.
Management attitude - "The more operating management comes into daily contact with the members of their res. labs, the more likely management is to develop that research attitude towards its current practice.	No.4 Mar.13.68 P.77	Prof.Bladen	We Agree.

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Managerial Gap. "What about the managerial gap which is developing." Managers less aware of importance of R&D	No.8 Nov.6.68 P.979	Sen.Lamontagne	This exists and a suggestion for correction is given in the brief.
Minimum size of firm - "There is a minimum size of firm in order to be able to earn enough profits to pay for the R&D"	No.5 Mar.19.68 P.92	Prof.Blackett	Generally true. This is linked with the cooperative research institutions.
Mutual enrichment of science and organization and difficulties of same - funds for science must come from increase of G.N.P.	No.2 Oct.9.68 P.20	Dr.J.Spaey	A Point of importance the Committee should consider.
National aim that creates enthusiasm is needed.	No.10 Apr.17.68 P.189.	Dr. Selye	We Agree
National Goals. National Unity. Full Employment. Rising G.N.P.per capita. Elimination of poverty. Improved health services. Help for Indians & Eskimos Major contribution to World peace.	No.3 Mar.13.68 P.49	Dr.Solandt	To there we would add- Maintenance of amenities.
National goals -	No.8 Nov.6.68 P.957	Sen. Mackenzie	See Above.
National Res.Dev.Corp. founded - (U.K.)	No.5 Mar.19.68 P.91	Prof.Blackett	After a difficult period this is apparently a success. Something similar for Canada should be considered.
National Res.C. Div. of pure Chemistry & pure physics - closer links with universities suggested.	No.11 Nov.26.68 P.1269	Dr.Solandt.	We believe this can best be done by training students for Master & P.H.D. degrees at NRC
National Science Library	No.3 Oct.23.68 P.110	N.R.C. Report.	One of the most outstanding in the world.

Need for scientists to be in touch universally.	No.10 Nov.21.68 P.1125	Agric. Report.	We agree.
Northern Resources Development - New important field.	No.3 Mar.13.68 P.53.	Dr.Solandt.	We agree.
Obsolescence.	No.9 Apr.17.68 P.172 - 174	Mr.C.Wright	There are two problems which should be considered. (1) The qualified but uncreative person working under a gifted leader or with a gifted subordinate. When the influence is removed this person is "obsolete". There is no cure. (2) The problem of overloading creative persons with administrative details while still in the prime of creative capability.
Obsolescence - Technical. The most skilled workers sometimes become obsolescent fastest.	" P.174	"	We agree. See our recommendations re leave-of-absence policy in our brief.
Obsolescence at 40	No.10 Nov.21.68 P.1083	Chairman quoting Dr.Uffen	We disagree. If this occurs and is not caused by points 1 or 2 above (obsolescence), the supervisor is at fault.
"There are some people who lose their effectiveness by virtue of the fact that their science has gone beyond them.	No.10 Nov.21.68 P.1083	Dr.Migicovsky	We agree. See discussion above.
Obtaining best scientists and working directors. - vital to effective research.	No.5 Oct.30.68 P.652.	Dr.Gray	We agree.
Oceanography - of great significance	No.6 Mar.20.68 P.119	Prof.Porter	We agree. DEMR appears to have first-class effort in this field.

Organizations whose missions have been accomplished - or which have failed tend to follow diffuse programs.	No.11 Nov.26.68 P.1259	Sen.Grosart	
Continuing tech. audit.	"	"	These are good points.
Essential element.	"	"	
Output of engineers "not growing at all - % at University dropping every year."	No.3 Mar.13.68 P.50	Dr.O.Solandt.	We feel that the actual effective output about the same, though percentage is dropping.
Overall priority judgments	No.9 Apr.17.68 P.170.	Mr.C.Wright	If Mr. Wright can truly show us how to make priority judgments, we feel that this would be of inestimable value to Canada.
Patents - Research Output	No.3 Oct.23.68 P.124	N.R.C. Report.	We have considered this in our brief
Peace Research	No.4 Oct.24.68 P.286.	Sen.Kinnear	This should be part of Canadian National Science Policy.
People - choice of good people	No.6 Mar.20.68 P.119	Prof.Porter	As pointed out previously this is the fundamental limitation on rate of progress.
Ph.D Graduate returning to University employ. Increasing from 53-70% from 1960-73.	No.3 Oct.23.68 P.34	Dr.Schneider	See our brief on the effect of this intellectual incest.
Ph.D's and their usage in Industry.	No.3 Oct.23.68 P.63.	Dr.Schneider	Effective use of Ph.D's in industry is to a considerable extent impeded by their attitude. See Appendix 4.

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Ph.D's in research & physics rather than engineering	No.3 Oct.23.68 P.64	Sen.Bourget	We agree, and suggest the reasons are: (a) Engineering courses are difficult. People tend to shy away from them. (b) Engineering demands use of one's skills & faculties to solve the problem at hand, whereas today's Ph.D's wish to continue the subject of their thesis.
Ph.D cycle	No.5 Oct.30.68 P.676	Sen.Lang Dr.Gray	The Ph.D cycle must be broken. See brief for suggestions.
Ph.D cycle	No.8 Nov.6.68 P.958	Sen.Mackenzie	
Ph.D's - No surplus	No.8 Nov.6.68 P.982.	Dr. Solandt.	The ones produced must be useable in the society we will have.
Ph.D - How valid are the numbers produced as an index of scientific manpower.	No.3 Oct.23.68 P.67	Sen.Grosart	Should not be valid. Suggestion for a change are contained in our brief.
Ph.D -"Any laboratory would go for a Ph.D."	"	Dr.Schneider	We disagree.
Ph.D's research - difficulty to find worthwhile projects for thesis. Cooperative management should be made between Universities and major research Centres.	No.5 Oct.30.68 P.649	Dr.L.Gray	We agree with both points.
Place to do research is somewhere as close as possible to practice.	No.10 Nov.21.68 P.1085	Sen.Grosart	We agree. A most important point for industrial research.
Points omitted from Science council report "Unduly negative". "Social science" Auxiliary services receive only brief references 'Incentives' Managerial Gap.	No.8 Nov.6.68 P.979 - 8	Sen.Lamontagne	The Report does not attempt to answer the basic questions,which we see as:- (1) What mechanism will be used to decide the amount to be spent and how to

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			divide it? (2) How will co-ordination be achieved? (3) How will projects be chosen? (4) What precisely will be the mechanism of action and most direct communication link between the Science body and Parliament?
Policy - centralize or not.	No.10 Apr.17.68 P.187	Dr.H. Selye	This is a leading problem.
- not mediocrity in many areas but excellency in a few.	"	"	We Agree.
Pollution - more can be achieved by regulation - than research.	No.5 Oct.30.68 P.651 P.674	Dr.Gray	Dr. Gray's views deserve respect.
Pollution - regulation has to be based on an understanding of both social & economic factors.	No.8 Nov.6.68 P.955	Dr.Solandt	Most certainly
Post-doctoral - for age group 27 - 30. i.e. a year off for research work.	No.4 Mar.13.68 P.84	Prof.Bladen	Would give productive results.
Priorities - Economic Growth. Education. Health.	No.3. Mar.13.68 P.55	Dr.Solandt	Economic growth should not be supported to the detriment of other values.
Priorities - Transportation Agriculture Pulp & Paper Water Oceanography Arctic.	No.6 Mar.20.68 P.118	Prof.Porter	These are all priority items.
Priorities - decision look at past successes"	No.10 Apr.17 P.190-192	Dr.H.Selye	We Agree.
Priorities - importance of priorities increases, the farther one gets away from the basic research.	No.1 Oct.9.68 P.3	Mr.Mackenzie	True, because expense increases.

Professional staff to have enthusiasm and motivation	No.5 Oct.30.68 P.754	Appendix 8	This is the difference between 25% and 85% effectiveness in our experience.
Project must fit programme area - as it is the programme area that gets the priority.	No.10 Nov.21.68 P.1081	Dr.Migicovsky	Concentration is the keynote
Projects mostly initiate from research workers? Yes.	No.10 Nov.21.68 P.1080	Mr.Williams	This agrees with our experience. Such projects are worthwhile only if workers are in close contact with the "real world" process. Two-way communication is essential.
Problem - to obtain higher rate of growth of research in industry - it is easier to see how to improve in University & Government.	No. 11 Nov.26.68 P.1267 P.1265	Dr.Solandt	See our brief
Proportion of the world's scientific papers - say in chem: & physics published almost parallel with G.N.P. of the countries.	No.14 Apr.25.58 P.277	Dr.King	Underlines the vital importance of this National dialogue.
Public support - for research often difficult because of vested interests	No.13 Apr.24.68 P.262	Dr.Nelson	A national science policy should take this into account.
Publication - excess in writing up trifling minor things to justify renewal of grant.	No.10 Apr.17.68 P.192	Dr.H. Selye	We Agree.
Publication - importance of - in research process	No.3 Oct.23.68 P.113	N.R.C. Report	We agree. This imposes discipline & improves quality of work.
Pulp & Paper Industry "we have been pretty successful in the sector of the pulp & paper Industry"	No.4 Mar.13.68 P.82	Sen.Lamontagne (Chairman)	See earlier note on cooperative research.
Pure scientific papers used as criteria for research productivity.	No.10 Nov.21.68 P.1080	Mr.S.Williams (agric).	This is valid if of necessary standard.

Purpose of Enquiry. "The broad principles - long-term financial requirements - structural organization of a dynamic & efficient scientific policy for Canada.	No.1 Mar.12.68 p.1.item (d)	Sen.Lamontagne	We have kept this definition in mind.
Qualified - Highly motivated staff. -availability determines success.	No.5 Oct.30.68 P.648	Dr.L.Gray	See our comments under "Professional Staff"
Ratio of technicians to professional staff: Ratio depends on work	No.3 Oct.23.68 P.73	Sen.Carter	We agree. See discussion on this in "The Principles & Detailed Mechanics of Research Direction & Management".
Ratio of professionals to technicians (Support staff) 1:3.	No.10 Nov.21.68 P.1051	Mr.Williams (Min.Agric.)	See Above
Recognized leaders attract good scientists.	No.1 Oct.9.68 P.7	Mr.Mackenzie	Very true. Critical when building an organization.
Relationship of basic & applied science - beneficial cross-fertilization.	No.5 Oct.30.68 P.715	AEC Appendix 4	This is our experience also.
Relationship of education to productivity gap vis-a-vis U.S.A.	No.5 Mar.19.68 P.108	Prof.Blackett	We believe it a mistake to sacrifice educational quality for quantity.
Relationships between those who can apply its findings & those responsible for deploying the overall scientific effort must be established.	No.14 Apr.25.68 P.273	Dr.King	A management problem.
Relevancy of research	No.3 Mar.13.68 P.52	Dr.Solandt	Poor choice of project is the most common research failing.
Representatives from competing fields of sciences.	No.11 Apr.18.68 P.216	Dr.Killian	Should be included when making major policy decisions.

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Research Bolster - You need only one very outstanding master in a school to attract students and assistants.	No.10 Apr.17.68 P.193	Dr.H.Selye	Invariably true.
Research - so little in industries in Canada percentage wise.	No.3 Oct.23.16 P.50	Dr.Schneider	See brief for suggestions.
Research - Development in Industry - it is hard work to get good results out of Canadian Industry.	No.5 Oct.30.68 P.676	Dr.Gray	Their comments should be borne in mind when considering expansion of work in industry. The major constraint in quality of man-power.
Scarcity of Men - Not Money.	No.4 Mar.13.68 P.676	Prof.Bladen	We agree. Several comments above.
Research & Development - "incredibly little attention paid to the really difficult problems of promoting R&D.	No.4 Mar.13.68 P.73	Prof.Bladen	Courses needed for management.
Research Scientists - "Good research requires good scientists." "Qualified research Scientists cannot be made in a day."	No.2 Mar.12.68 P.35 P.39	Dr.Mackenzie "	We certainly agree
Retaining access to information means making contributions too!	No.4 Oct.24.68 P.298	Maj.Gen. Waldock	A vital point in the conduct of technical work all too often overlooked.
Retraining Scientists & Age factors	No.5 Oct.30.68 P.678	Dr.Lewis Chairman Dr.Gray	See our comments under "Age"
Returns - Delayed benefits - are not separately identifiable benefits to society.	No.9 Apr.17.68 P.171	Mr.C.Wright	We agree. The underlying point is also applicable to industrial research.
Satellite vs. Cables	No.12 Apr.18.68 P.241	Sen.Carter	A considerable body of opinion supports the view that modern cable techniques may be economically superior. This difference of opinion should be resolved before committing large expenditures.
Time Delay	No.12 Apr.18.68 P.242	Dr.Solandt	

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Science can be a catalyst in society - and an innovator.	No.14 Apr.25.68 P.273	Dr.King	We agree.
Science - disadvantages have been colossal - always has destroyed something and takes away certain inherent values of life.	No.10 Mar.20.68 P.188	Dr.Selye	We agree.
Science - expenditure on science and research is less than optimum amount.	No.3 Mar.13.68 P.51	Dr.Solandt	The identification of the mechanism determining extent and amount of expenditure we see as one of the objectives of the committee.
Science - Policy - artificiality of a separate entity called science Policy.	No.13 Apr.24.68 P.257	Dr.Nelson	We disagree.
Science - reasons for support by nation. "cultural activity" "economic" "application of science to the solution of social problems"	No.3 Mar.13.68 P.46	Dr.O.Solandt	Valid Points.
Science - serving the nation - views to be put to political leaders by scientific community.	"	"	Agree this is essential.
Science - special requirements of Canada.	" P.48	"	We agree with points made.
Science - should it influence political policy?	No.13 Apr.24.68 P.263	Sen.Grosart	It must.
Science - as an essential national activity of its own.	No.3 Oct.23.68 P.32	Dr.Schneider	It is a national investment.
Scientific - Administrators qualifications.	No.11 Apr.18.68 P.232	Dr.Killian	We agree with points made by Dr. Killian.
Scientific - change rate - "we are going to be over-run by the rate of physical & scientific change and our society's disruption by it.	No.1 Mar.12.68 P.7	Dr.Corry	Yes, if planning is not done in time to be useful.

Scientists and accidents. "Certain amount of freedom has to be given to every original scientist: you have to let him have accidents."	No.10 Mar.20.68	Dr.Selye	We agree.
Scientists & Engineers in Government "need more in legislative bodies."	No.11 Apr.18.68 P.232	Dr.Killian	We.agree.
Scientists manage own affairs - within the budget which a nation provides for basic science.	No.5 Mar.19.68 P.90	Prof.Blackett	We agree.
Similarity between R&D - and War.	No.5 Oct.30.68 P.651	Dr.Gray	A good analogy.
Social & Economic Terms - in scale of expenditure - need to consider.	No.11 Apr.18.68 P.216	Dr.Killian	Of course.
Splitting of pure and applied Science - would be a serious mistake.	No.3 Oct.23.68 P.39	Dr.Schneider	We agree.
Stimulation of Research in Canada. "Pet companies in Canada to use modern technology very effectively - in their particular branch of industry."	No.11 Nov.21.68 P.265 - P.266	Sen.Lamontagne	We agree. This would be the biggest single step in the improvement of Canadian Industry.
Stopping of Projects - Decision made by research director himself.	No.14 Apr.25.68 P.289	Dr.King	The critical item is the choice of projects. However, it <u>is</u> the Research Directors' decision.
Stopping and Starting - it is very important to know what experiments to start, but it is much more important to know what experiments to stop.	No.5 Mar.19.68 P.105	Prof.Blackett	The wrong way around. With due Respect.
Support cells of excellence.	No.5 Oct.30.68 P.653	Dr.Gray	Yes indeed.

Systems Engineering - Interdisciplinary Research.	No.3 Oct.23.68 P.39	Dr.Schneider	We support interdisciplinary research which encompasses systems engineering.
Technological Gap - Vis-a-vis U.S.A. "education and management as much as it is science and engineering."	No.11 Apr.18.68 P.224	Dr.Killian	We agree.
Technology - Minister of "as employer as well as policy maker regarded as a mistake by many.	No.5 Mar.19.68 P.90 - 91	Prof.Blackett	This is true, on the principle that directors direct, researchers research. To do both functions in one body makes impartial judgments impossible.
Technology produced at a cost by investment in "research & development.	No.4 Mar.13.68 P.71	Prof.Bladen	Yes, again, it is a viable national investment.
Termination of projects - which are exhausted.	No.3 Oct.23.68	Sen.Hays	We agree - termination of R&D is one of the critical points.
Transportation - Needs more application of science.	No.3 Mar.13.68 P.53	Dr.Solandt	We agree.
Wastage - Money - and by tackling technological problems with too few resources."	No.5 Mar.19.68 P.92	Prof.Blackett	A very common error, not only for countries but for companies.
Wastage - Time in administration.	No.10 Apr.17.68 P.202	Dr.Selye	We are 100% in agreement.
Weigh value of each individual demand against competition from other demands on our resources.	No.3 Mar.13.68 P.51	Dr.Solandt	This is an essential management problem.
Younger men to be supported - who had not yet won complete recognition by the older professors in their country and who tended to be excluded.	No.14 Apr.25.68 P.280	Dr.King	We agree.

APPENDIX II

TABLE OF COMPARISON LAST THREE YEARS OF
HIGH SCHOOL (SCIENCE ORIENTED) U.S.A. AND U.S.S.R.

Comparison of School Hours of Russian Technical School and Boston College Prep. Course

	RUSSIAN G. VIII	AMERICAN G. X	RUSSIAN G. IX	AMERICAN G. XI	RUSSIAN G. X	AMERICAN G. XII
OWN LANGUAGE	5½	3 3/4	4	3 3/4	4	3 3/4
MATHS. (Alg: Geom; Trig)	6	3 3/4	6	3 3/4	6	6 3/4
HISTORY	4	3	4	3	4	-
CIVICS	-	-	-	-	1	-
NATURAL SCIENCE	2	-	1	-	2	-
FOREIGN LANGUAGE	3	3	3	3	3	3 3/4
SHOP WORK	2	-	2	4½	2	-
PHYSICAL EDUCATION	2	-	2	-	2	-
DRAFTING	1	3 3/4	1	-	1	3
PHYSICAL SCIENCE	5	3	7	4½	8	7½
GEOGRAPHY	2½	-	3	-	-	-
O.T.C.	-	3/4	-	3/4	-	3/4
HEALTH	-	2 1/4	-	-	-	-
	33 hrs.	23 1/4	33 hrs.	23 1/4	33 hrs.	25½ *

RUSSIAN SCHOOL DAY — 5 or 6 hours of study 6 days a week 33 weeks a year No electives

BOSTON SCHOOL DAY — 4½-5 hrs. of study - 5 days a week - 180 days

*Assuming electives taken.

APPENDIX III

TYPICAL CORRESPONDENCE COURSE LESSONS WOLSEY HALL, OXFORD, ENGLAND, FOR SCIENCE SUBJECTS CORRESPONDING TO CANADIAN GRADE X

This Appendix is provided to show the difference between British and Canadian technical standards at a common age level. We do not include this to praise the U.K. system. The German, Swedish and Dutch systems are probably better, but we chose this as an example in a convenient Canadian language.

The subjects are:

Applied Mathematics
Pure Mathematics
Chemistry
Zoology

Course lessons are in the Senate Master Copy only.

WOLSEY HALL
OXFORD

APPLIED MATHS. SCHEME OF STUDY

TEXT-BOOK

You may use

EITHER:

Humphrey & Topping: Shorter Intermediate Mechanics........Longmans

OR:

Humphrey (ed. Topping): Intermediate Mechanics (2 vols.)..Longmans

but your choice must bear in mind the following:

(1) If your syllabus includes Hydrostatics, which is still set by a few G.C.E. Boards, the Shorter Intermediate Mechanics is necessary, as this branch of the subject is not in the 2-volume work.

(2) If your syllabus includes any or all of Bending and Shearing Moments, Virtual Work, Stability Criteria and detailed treatment of Vectors, you will require Volume 2 of the 2-volume work for these topics. Should this be the case, and Hydrostatics is not in your syllabus, you will find it best to use the 2-volume work throughout.

For most students, the Shorter Intermediate Mechanics will suffice; but all students should carefully read their examination syllabus and check the requirements against the contents of the Lessons shown on their Wolsey Hall time-table (or register). The contents of the Lessons are given below under Arrangement of Lessons.

You will be sent only those Lessons of this Course which are required by your syllabus - for example, you may not be sent Lessons 27-33 on Hydrostatics and may receive Lesson 35 for reading of its Specimen Answers only.

ARRANGEMENT OF LESSONS

[The references below are to the 1964 editions of the text-books. Those without a distinguishing letter are to the Shorter book; D. indicates volume 1 and S. indicates volume 2 of the 2-volume work.]

Lesson	Subject	Text-book (chs.)
	STATICS	
1	Force acting at a point.	10 to 10.24 D. 3 to p.110; S. 1 to p.29
2	Conditions of Equilibrium.	10.25 to end S. 1, pp.29 to end
3	Parallel Forces; Principle of Moments.	11-11.17 S. 2 to p.63
4	Balances, Levers, Couples.	11.17-11.24; 12.16-12.19 S. 2, p.63 to end, 3, pp.131-36,149-50
5	Three or More Co-planar Forces.	12-12.10 S. 3 to p.100
6	Jointed Rods. Further Work on Co-planar Forces.	12.11-12.27 S. 3, pp.103-145

Lesson	Subject	Text-book (chs.)
7	Graphic Statics, Light Frameworks.	13.1-13.5; 13.7 to end S. 4 to p.163
8	Graphic Statics; Parallel Forces; Further examples on Frameworks.	13.6; S. 4, p.164 to end
9	Friction.	14; S. 5
10	Work, Machines.	4 pp.128-29; 15 D. 4, pp.164-65, 175-76,189-94 S. 6
11	Centre of Gravity	16 S. 7
12	REVISION. EXAMINATION PAPER.	
13	SPECIMEN ANSWERS TO EXAMINATION PAPER.	
	DYNAMICS	
14	Speed, Velocity, Relative Angular Velocities.	1; D. 1 to 1.33
15	Acceleration; Equations of Motion.	2.1-2.8; 2.18 to end D. 2-2.8; 2.18-2.23
16	Vertical Motion Under Gravity.	2.9-2.17 D. 2.8-2.17
17	Force, Momentum, Friction.	3 to 3.18 D. 3-3.16
18	Work and Power.	3.18 to end; 4 to 4.6 D. 3.18-3.20; 4-4.10; 4.19-4.20; 4.22
19	Units and Dimensions.	4.7 to end D. 4.19-4.24
20	Impulsive Forces.	5 to 5.10 D.5-5.10
21	Impact of Elastic Bodies.	5.11 to end D. 5.11-5.16
22	Projectiles.	6 to 6.12 D. 6
23	Motion in a Circle.	7; D.7
24	Simple Harmonic Motion.	8; D. 8
25	REVISION AND EXAMINATION PAPER.	
26	SPECIMEN ANSWERS TO EXAMINATION PAPER.	
	HYDROSTATICS	
27	Fluid Pressure; Thrust on Plane Surface.	17
28	Centres of Pressure.	18
29	Resultant Thrust on any Surface.	19; 20.6-20.9
30	Equilibrium of Floating Bodies.	20
31	Gases.	21
32	REVISION AND EXAMINATION PAPER.	
33	SPECIMEN ANSWERS TO EXAMINATION PAPER.	

Lesson	Subject	Text-book (chs.)
	GENERAL	
34....	Moments of Inertia, etc. Special Lesson	9 S. 8
35....	Shearing and Bending Moments. Special Lesson.	S. 8 to p.344
36....	REVISION AND EXAMINATION PAPER.	
37....	SPECIMEN ANSWERS TO EXAMINATION PAPER. Vectors (Special Notes).	S. 10.1-10.19; 10.21-10.23.
38....	REVISION of Vectors.	

PRELIMINARY INFORMATION

This Course is designed to cover examination requirements comprehensively. Importance is attached to revision at the end of each stage and again on the completion of the whole Course, and you are urged to attempt a thorough review of your previous work at each of the revision points.

In a Mathematical subject, the setting out of results is always important, and the method given for book work should therefore be carefully noted. Each line in the argument should be weighed and in your own work you should state clearly each step in the reasoning. Practice will enable you to set out the argument in this way with each step linked logically to the preceding or following step. It is a great help to visualize each stage mentally before writing anything.

In Applied Mathematics the PRINCIPLES of the subject in its various branches MUST be understood. SUCCESS IN WORKING OUT PROBLEMS DEPENDS ON THE CORRECT APPLICATION OF CERTAIN PRINCIPLES RATHER THAN ON THE USE OF MEMORISED FORMULAE, HOWEVER WELL THESE ARE REMEMBERED. MEMORY CANNOT TAKE THE PLACE OF UNDERSTANDING.

The application of the appropriate principles will give rise to one or more equations, and the solution of the problem will then depend on the solution of these equations. When an equation is written down, the underlying principle should be stated (this is a necessary part of the step-by-step statement of reasoning emphasised above). Care must be taken that all quantities introduced into the working out of the problem are in correct units; and that, if the units are not already fixed by the problem set, the units chosen will be such that they lead to as simple a solution as possible.

Very often a drawing will be required to illustrate the working-out of a problem. Let the drawing be neat, although great accuracy is not usually required unless the problem is to be solved graphically. In the latter case, utmost accuracy is needed; and a large scale for the drawing is necessary to ensure accurate results. In all drawings make sure that the figure given corresponds with that required by the text, and take pains to define properly the positions of lines and points. Geometrical methods may be used for illustrating a theorem.

A completed answer should be checked by your re-reading the question and confirming that all parts of it have been answered and all data used. If some of the data have not been employed, an error has probably occurred. In actual examinations, you are advised to work out the easier problems first and the book-work that you know well, leaving the more difficult questions to be done after the easier ones have been disposed of. A small number of questions worked to a successful solution is worth more than a large number badly or half worked.

E.W. ROBERTS, M.Sc.

EXAMPLES TO BE WORKED

Below are given two lists showing the Examples in the text-books that you should work for practice in connection with the Lessons of the Course. The first list gives the examples in the one-volume "Shorter Intermediate Mechanics"; the second gives the location of the same examples in the two-volume "Intermediate Mechanics". In both lists, the 1964 edition is meant. Any references in the actual Lessons which differ from these below should be ignored, as relating to the older editions. Refer constantly to these lists.

Lesson	Examples in One-Volume Edition (1964)
1	p.375, nos. 2, 4, 8, 12, 17, 18; p.385, nos. 5, 10, 15, 17, 21; p.394, nos. 1, 3, 7, 11, 16.
2	p.399, nos. 1, 3, 4-7; p.408, nos. 2, 4, 5, 9, 11, 12, 15, 17, 19, 23, 24.
3	p.418, nos. 2, 4, 5, 8-10; p.425, nos. 1-6 inc.; p.428, nos. 2, 6, 9, 11, 12, 14, 19, 24, 25.
4	p.438, nos. 1-9 inc.; p.498, nos. 1, 3, 5, 7, 9.
5	p.450, nos. 3, 5, 8, 10, 11, 14, 16, 17, 20, 22, 24; p.464, nos. 3, 4, 5, 8, 9, 11-13.
6	p.475, nos. 1, 3, 7, 8, 16, 20, 24, 27; p.485, nos. 1, 2, 5, 11, 15, 17, 23; p.491, nos. 1, 3, 9, 16; p.498, nos. 1-4, 10, 17, 19; p.507, nos. 1, 3, 7, 13, 17, 20.
7	p.540, nos. 1, 3, 5, 7, 8, 10, 11, 14.
8	p.529, nos. 1-3, 8, 10; p.540, nos. 15, 17, 21, 26, 29, 30.
9	p.559, nos. 1, 2, 4, 6, 9, 11; p.563, nos. 1, 2, 4, 6, 8; p.566, nos. 1, 2, 5, 6; p.570, nos. 1, 3, 5, 6, 11, 16, 22, 25.
10	p.583, nos. 1, 2, 3; p.590, nos. 1, 2, 4; p.592, nos. 1, 3, 5, 7, 9, 11, 13, 19, 20.
11	p.601, nos. 3, 7, 11, 12; p.610, nos. 2, 6, 8, 10, 14, 18, 21, 25, 30, 38, 43, 47, 51; p.616, nos. 2, 4, 8, 12; p.634, nos. 3, 5, 10, 14, 17; p.624, nos. 1, 3, 7.
12	Revision Examples E, pp.636-644.
14	p.22, nos. 1, 4, 7, 10, 13; p.29, nos. 1, 4, 7, 10, 13, 16; p.35, nos. 1, 4, 7, 10, 13; p.41, nos. 1, 4, 7, 10, 13, 16; p.50, nos. 2, 4, 6, 8.
15	p.59, nos. 1, 3, 5, 8, 12, 14, 16, 19, 23, 27, 30, 32; p.80, nos. 1, 3, 5, 8, 14, 18-20.
16	p.65, nos. 1, 3, 5, 7, 9, 12, 13, 16, 18; p.70, nos. 1, 2, 4, 6, 8, 10.
17	p.101, nos. 1, 4, 7, 10, 13, 15, 17, 20, 22; p.111, nos. 1, 6, 10, 13, 18, 20.
18	p.120, nos. 1, 4, 7, 9, 11, 15, 17, 20; p.134, nos. 2, 4, 6-12.
19	p.145, nos. 14, 18, 20; p.156, nos. 2, 4, 8, 10, 11, 14, 18; p.163, nos. 2, 4, 6, 8, 10, 12, 14.
20	p.172, nos. 1, 3, 5, 7, 9, 12, 13, 15, 18, 19, 23; p.182, nos. 1, 2, 3, 6, 8, 9.
21	p.193, nos. 1, 3, 5, 7, 10, 12, 14, 18, 22; p.200, nos. 1, 3, 5, 7, 8; p.208, nos. 2, 3, 5, 6, 10.
22	p.218, nos. 1, 2, 5, 7, 9, 10, 14, 18, 21, 24; p.228, nos. 1, 2, 4, 6, 9; p.231, nos. 1, 3, 4, 7, 8.

Lesson	Examples
23	p.252, nos. 1, 3, 5, 8, 10; p.259, nos. 2, 4, 7, 9, 11, 13, 16; p.268, nos. 1, 4, 6, 10, 13, 17; p.281, nos. 1, 4, 8, 11, 15, 19.
24	p.294, nos. 1, 3, 4, 7, 9, 12, 19; p.305, nos. 1, 3, 5, 7, 12, 16, 20; p.313, nos. 1, 3, 5, 6, 9, 11.
27	p.652, nos. 1-5; p.659, nos, 3, 5, 7, 8, 10; p.666, nos. 1, 3, 4, 7, 9, 11, 12, 16.
28	p.681, nos. 1, 3, 5, 7, 8, 10, 12, 17, 18, 20, 22, 2 .
29	p.693, nos. 1-12; p.715, nos. 29, 30.
30	p.711, nos. 2, 4, 6, 9, 12, 15, 18, 24; p.717, nos. 1, 3, 6; p.727, nos. 1-10.
31	Examples 21, p.734, nos. 1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 20.
34	Examples 9.1, 9.2, 9.3, 9.4, as many as possible.
35	(The examples for this Lesson are from Vol. 2 of Humphrey's 2 volume work, Intermediate Mechanics, p.338, nos. 2, 3, 5, and p.344, nos. 1, 3, 4, 7, 9, 11, 14.)

Examples in Two-volume Edition (1964)

[Note: S = Statics volume; D = Dynamics Volume]

Lesson	
1	S p.10, nos. 2, 4, 8, 12, 17, 18; p.20, nos. 5, 10, 15, 17, 21; p.29, nos. 1, 3, 7, 11, 16.
2	S p.33, nos. 1, 3, 4-7; p.43, nos. 2, 4, 5, 9, 11, 12, 15, 17, 19, 23, 24.
3	S p.53, nos. 2, 4, 5, 8-10; p.60, nos. 1-6 inc.; p.63, nos. 2, 6, 9, 11, 12, 14, 19, 24, 25.
4	S p.73, nos. 1-9 inc.; p.136, nos. 1,3,5,7,9.
5	S p.86, nos. 3, 5, 8, 10, 11, 14, 16, 17, 20, 22, 24; p. 100, nos. 3, 4, 5, 8, 9, 11-13.
6	S p.111, nos. 1, 3, 7, 8, 16, 20, 24, 27; p.122, nos. 1, 2, 5, 11, 15, 17, 23; p.129, nos. 1, 3, 9, 16; p.136, nos.1-4, 10, 17, 19; p.145, nos. 1, 3, 7, 13, 17, 20.
7	S p.178, nos. 1, 3, 5, 7, 8, 10, 11, 14.
8	S p.167, nos. 1-3, 8, 10; p.178, nos. 15, 17, 21, 26, 29.
9	S p.206, nos. 1, 2, 4, 6, 9, 11; p.210, nos. 1, 2, 4, 6, 8; p.213, nos. 1, 2, 5, 6; p.217, nos. 1, 3, 5, 6, 11, 16, 22, 25.
10	S p.253, nos. 1, 2, 3; p.260, nos. 1, 2, 4; p.262, nos. 1, 3, 5, 7, 9, 11, 13, 19, 20.
11	S p.271, nos. 3, 7, 11, 12; p.280, nos. 2,6,8,10,14,18,21, 25, 30, 38, 43, 47, 51; p.288, nos. 2, 4, 8, 12; p.311, nos. 3, 5, 10, 14, 17; p.299, nos. 1, 3, 7.

Lesson

12	Revision Examples B, pp.315-327.
14	D p.23, nos. 1, 4, 7, 10, 13; p.31, nos. 1, 4, 7, 10, 13, 16; p.37, nos. 1, 4, 7, 10, 13; p.43, nos. 1, 4, 7, 10, 13, 16; p.52, nos. 2, 4, 6, 8.
15	D p.68, nos. 1, 3, 5, 8, 12, 14, 16, 19, 23, 27, 30, 32; p.94, nos. 1, 3, 5, 8, 14, 18-20.
16	D p.75, nos. 1, 3, 5, 7, 9, 12, 13, 16, 18; p.79, nos. 1,2,4, 6, 8, 10.
17	D p.117, nos. 1, 4, 7, 10, 13, 15, 17, 20, 22; p.127, nos. 1, 6, 10, 13, 18, 20.
18	D p.136, nos. 1, 4, 7, 9, 11, 15, 17, 20; p.170, nos. 2, 4, 6-12.
19	D p.182, nos. 14, 18, 20; p.194, nos. 2, 4, 8, 10, 11, 14, 18; p.213, nos. 2, 4, 6, 8, 10, 12, 14.
20	D p.223, nos. 1, 3, 5, 7, 9, 12, 13, 15, 18, 19, 23; p.233, nos. 1, 2, 3, 6, 8, 9.
21	D p.246, nos. 1, 3, 5, 7, 10, 12, 14, 18, 22; p.254, nos. 1, 3, 5, 7, 8; p.261, nos. 2, 3, 5, 6, 10.
22	D p.280, nos. 1, 2, 5, 7, 9, 10, 14, 18, 21, 24; p.290, nos. 1, 2, 4, 6, 9; p.293, nos. 1, 3, 4, 7, 8.
23	D p.329, nos. 1, 3, 5, 8, 10; p.337, nos. 2, 4, 7, 9, 11, 13, 16; p.346, nos. 1, 4, 6, 10, 13, 17; p.363, nos. 1, 4, 8, 11, 15, 19.
24	D p.378, nos. 1, 3, 4, 7, 9, 12, 19; p.389, nos. 1, 3, 5, 7, 12, 16, 20; p.399, nos. 1, 3, 5, 6, 9, 11.
34	D Examples 10.1, 10.2, 10.3, 10.4, as many as possible.
35	S p.338, nos. 235; p.344, nos. 1, 3, 4, 7, 9, 11, 14.

[Lessons omitted from the lists above do not require examples to be worked. Lessons 27-31 are omitted from the second list because they are taken only by students using the one-volume edition.]

ALGEBRA
INTERMEDIATE GRADE

WOLSEY HALL
OXFORD

ALTERNATIVE SCHEME OF STUDY
BAKER & BOURNE

TEXT-BOOK

Baker & Bourne: Elementary Algebra (with Answers)....Bell.

The Text-Book recommended for use by students studying Intermediate Algebra is:

Page: Algebra.. ..................................U.L.P..

As some students find the explanations in this book difficult to understand, this Scheme based on Baker & Bourne, Elementary Algebra, has been prepared. This alternative text-book is rather less advanced and the explanatory matter is more clearly expressed.

This Alternative Scheme is to be used throughout your Course. The references to Baker & Bourne below, for each Lesson, are to be substituted for the references to Page which appear in the Lessons themselves under the heading "Week's Work". If your Course does not contain some of the Lessons to which references are made below, the references to those particular Lessons should be ignored.

ARRANGEMENT OF LESSONS

Lesson I

Subject........Theory of Quadratic Equations
Reading........Baker & Bourne, Elementary Algebra, Ch.XXXII
Examples.......p.266, Nos.7,9,11,14,16,22,25,29,32,33,38,42,
44,46,48,50, as a minimum.

Lesson II

Subject........Variations, Surds, Ratio and Proportion.
Reading........Baker & Bourne, Elementary Algebra, Chs.XXXVI,XXXVIII.
Examples.......p.302, Nos.5,8,15,18,19,21,23,25,27,29.
p.316, Nos.11,13,22,26,28,33,36,43,49,54,60,69,73,9.
p.321, Nos.7,11,16,23,28,29,31.
p.327, Nos.8,13,19,26,30,36,40,42,43.

Lesson III

Subject........Theory of Indices and Logarithms.
Reading........Baker & Bourne, Elementary Algebra Chs.XXXVII,XXXIX.
Examples.......p.308, Nos.4,6,7,15,18,22,23,27,30,32,35,36,39,40.
p.337, Nos.6,9,13,19,22,25.
p.342, Nos.7,22,39,40,43,51,57,60,68,71,75,81,83,89.

Lesson IV

Subject........Progression, Convergency, Miscellaneous Series.
Reading........Baker & Bourne, Elementary Algebra, Chs.XLII,XLIII,
XLIV, XLV to p.385.
Examples.......p.368, Nos.47,52,58,63,67,71,73.
p.375, Nos.11,20,28,37,47,55,59,63,70,75,78,80,83.
p.378, Nos.10,12,14,15,17,20,21,3.
p.383, Nos.2,4,7,11,15,17,23,28,37,39,46,49,54,61.

Lesson V

Subject........Permutations & Combinations.
Reading........Baker & Bourne, Elementary Algebra Ch.XLVIII.
Examples.......p.404, Nos.4,7,14,16,20,25,27,30,34,37,38.
p.410, Nos.6,10,13,15,17.
p.414, Nos.4,8,12,14,17,18,26,30,33,35.
p.415, Nos.2,8,11,15,17,22,24,27.

Lesson VI

Subject........Binomial Theorem (Positive Integral Indices)
Reading........Baker & Bourne, Elementary Algebra, Ch.XLIX to p.429.
Examples.......p.421, Nos.5,11,17,21,28,30,32.
p.426, Nos.3,8,13,15,20,21,27,30,34,41,47,55,57.
p.429, Nos.2,3,4,6,8,9,10,11.

Lesson VII

Subject........Interest and Annuities.
Reading........Baker & Bourne, Elementary Algebra, Ch.LI.
Examples.......p.457, Nos.6,12,15,20,25,28,30.
p.461, Nos.1-16 inclusive.

Lesson VIII

Subject........Mathematical Induction and Partial Fractions.
Reading........Baker & Bourne, Elementary Algebra, pp.386-7,pp.475-8.
Examples.......p.387, Nos.1-14 inclusive.
p.478, Nos.2,7,9,13,15,20,25,26,28,30.

Lesson IX

Subject........Binomial Theorem for Negative and Fractional Indices.
Reading........Baker & Bourne, Elementary Algebra, pp.429-447.
Examples.......p.431, Nos.1-6 inclusive;
p.440, Nos.2,4,6,8,9,12,17,18,22,27,33,35,36;
p.441, Nos.1-11 inclusive;
p.445, Nos.1,4,9,13,17,22,30,33,35,36,38.

Lesson X

Subject........Exponential and Logarithmic Series.
Reading........Baker & Bourne, Elementary Algebra, Ch.LII.
Examples.......p.468, Nos.3,4,6,8,10,14,17,18,23,26,28,29.

Lesson XI

Subject........Solution of Cubic Equations. Horner's Method.

This Lesson is sufficient for all examination purposes at this stage.

Lesson XII

Subject........REVISION. Specimen Examination Paper.

Lesson XIII

Subject........REVISION. Model Answers to Specimen Examination Paper.

Constant practice is essential in this subject and to ensure this, students should work out the Revision papers given at intervals in Baker & Bourne, Elementary Algebra. A minimum selection is XLIi, XLIq, XLVIa, XLVIe, XLVIl; Lb, Lg, Lr, Lt.

WOLSEY HALL
OXFORD

ADVANCED GEOMETRY SCHEME OF STUDY

TEXT-BOOK

This Course was originally based on

Baker & Bourne: New Geometry.................................Bell,

which is now unfortunately out of print. A perfectly suitable alternative is

Hall & Stevens: School Geometry, Pts. IV-VI............Macmillan,

and references to this are given under Arrangement of Lessons below and overpage. References to Baker & Bourne in the Lesson Notes themselves should be ignored.

A SET OF MATHEMATICAL INSTRUMENTS

is essential, consisting of a RULER graduated in inches and tenths, and in centimetres and millimetres, SET SQUARES (90°, 45°, 45°) and (90°, 60°, 30°), COMPASSES with PENCIL, PROTRACTOR. These may be obtained at any stationer's shop, or from Wolsey Hall.

ARRANGEMENT OF LESSONS

Lesson	Subject	Hall & Stevens
1	Ratio & Proportion: Similar Triangles	pp. 247-285
2	Ratio & Proportion: Other Theorems	pp. 286-310
3	Ratio & Proportion: Problems	pp. 274-284
4	Geometry of Space: Properties of Planes	pp. 347-382
5	Solid Figures: Prisms	pp. 383-386, 392-397
6	Solid Figures: Pyramids	pp. 386-389, 398-410
7	Solid Figures: Cylinder, Cone, Sphere	pp. 411-433
8	REVISION.	

IMPORTANT INSTRUCTIONS

1. Geometry requires THOUGHT. It is useless learning Propositions by heart. Learn HOW they are done, and then proceed to do them IN YOUR OWN WORDS, and not in the words of the book.
   The great value of Geometry is to teach you HOW TO THINK AND REASON correctly; and Examiners require to see in your work proof that you have learnt to think for yourself.

2. Each Lesson consists of THREE PARTS, all of which must be done, and in the proper order.

   PART I TEXT-BOOK READING: This is the first and most important thing to be done, and yet we find that this part of the week's work is constantly neglected. Read and re-read the set portion of the text-book, with the aid of your Notes, until it is thoroughly grasped, completely understood. IF YOU DO NOT UNDERSTAND ANY POINT, WRITE AND TELL US (using a Special Inquiry Form supplied for the purpose), and we will try to make the point clear to you.

   PART II TEXT-BOOK EXERCISES: All those set should NEXT be done: Rider-work is the chief source of interest in geometry and the best test of geometrical progress. The student cannot have too much practice in working out problems. These, however, are NOT TO BE SENT TO THE TUTOR FOR CORRECTION. BUT, if there is any Exercise among those

set for the week that, after a fair trial, you are unable to solve, again WRITE AND TELL US (using another Special Inquiry Form). We will do our best to help you. For our own sake as well as yours, WE WANT YOU NOT TO PROCEED WITH THE NEXT LESSON TILL YOU QUITE UNDERSTAND EVERY POINT IN THE OLD ONE.

PART III TEST PAPER. Leave this till LAST. Do not look at it till both Reading and Exercises have been done. Then work the Test Paper, and send it to your Tutor for correction.

SCHEME OF REFERENCE TO HALL & STEVENS

LESSON 1: p.253, Nos. 1, 3, 4, 6, 7, 9; p.285, Nos. 2, 3, 4; p.259, Nos. 2, 3, 4, 5, 7; p.263, Nos. 1, 2, 3, 5, 7, 9.

LESSON 2: p.289, Nos. 2, 3, 5, 6; p.291, Nos. 1, 4, 7, 8; p.295, Nos. 1, 2, 4, 5; p.305, Nos. 1-5, 8.

LESSON 3: p.278, Nos. 1, 3, 6, 7, 8; p.284, Nos. 1, 5, 6, 7.

LESSON 4: p.361, Nos. 1 & 5; p.362, Nos. 1 & 2; p.369, Nos. 2 & 5; p.375, Nos. 4 & 5; p.381, Nos. 2, 4, 7.

LESSON 5: p.394, Nos. 7, 9, 13, 16, 17, 18.

LESSON 6: p.389, Nos. 1, 2, 3, 7, 9, 10; p.401, Nos. 1, 2, 3, 4, 6, 10, 13.

LESSON 7: p.414, Nos. 6, 8, 12; p.421, Nos. 2, 5, 6; p.427, Nos. 1, 2, 3; p.432, Nos. 1, 7, 8, 10.

LESSON 8: Revision of all the work is necessary giving special attention to Wolsey Hall Notes and to the Specimen Answers to the Test Papers together with your corrected attempts.

PROPOSITIONS EMPLOYED IN SPECIMEN ANSWERS

In the Specimen Answers to the Test questions, references are given, to the appropriate propositions in Baker and Bourne to be used in arriving at answers. Below are the corresponding propositions, etc., in Hall & Stevens.

TEST	HALL AND STEVENS
1. Ques. 2 (a)	Th.61, p.256
4 (a)	Th.62, p.260 converse of Th.61, p.256
2. Ques. 1 (a)	Th.72, p.290
3 (a)	Th.66, p.268
4 (a)	Th.77, p.303
4. Ques. 1 (a)	Th.81, p.352
6. Ques. 1 (a)	Para. 34, p.419
2 (a)	Para. 13, p.388
7. Ques. 1 (a)	Para. 35, p.420

G.W. PILKINGTON-ROGERS, M.A.,B.Sc.,F.C.P.

WOLSEY HALL
OXFORD

CALCULUS.A

SCHEME OF STUDY

TEXT-BOOK

Forrest: Calculus for Technical Students....................Arnold.

OR

Hunter: Groundwork of Calculus..............................U.T.P.

The Course may be studied in conjunction with either Forrest or Hunter; and to assist students a list of parallel references is given under Arrangement of Lessons, below, to show the portions of Hunter which correspond to the set reading in Forrest. But students using Hunter should note that for book-work on the matters dealt with in Lesson 7 they must depend on the tutor's notes in that Lesson.

PRELIMINARY INFORMATION

In this subject a new technique is introduced and the student must become thoroughly conversant with differentiation from first principles before treating the operation as an application of a number of rules and known results. In almost all examination papers questions are set to test the student's ability to deduce Differentials by this method.

The Course is independent of text-books, although Forrest and Hunter are named above, and students may choose examples from any book. It is well to make a special effort to master CALCULUS, because, as the questions set are not usually difficult, correct solutions may make all the difference between success and failure at the examination. Students proceeding to Higher Mathematics, Science, Economics, or Engineering subjects will find that a good knowledge of the groundwork in Calculus will prove most useful.

It is to be noted that every function may be differentiated but only certain types of functions can be integrated by simple methods. Differentiation of a function is the application of rules to the said function, but unless the function is or can be reduced into one of a number of standard forms, integration is not possible. These standard forms and their integrals must be committed to memory. Facility in applying the results to particular practical problems can be acquired only by working out large numbers of examples.

ARRANGEMENT OF LESSONS

Lesson	Subject	Forrest Chs.	Hunter Chs.
1	.....Gradients of Curves and Differentiation of Powers.............	II-III	I-II
2	.....Maxima and Minima.....................	IV	III to 39
3	.....Rate of Change of Function: Discrimination between Maxima and Minima...........................	V	III, 40-IV
4	.....Simple Integrations, Areas and Volumes..........................	VI-VII	VI-VIII

Lesson	Subject	Forrest Chs.	Hunter Chs.
5	General Methods of Differentiation	VIII	V
6	Differentiation and Integration of Trigonometrical, Logarithmic and Exponential Functions	IX	IX, X, XII
7	Further Methods of Integration	X to p.177	XI
8	REVISION AND EXAMINATION PAPER.		
9	MODEL ANSWERS TO EXAMINATION PAPER.		
10	Further Methods of Integration: Integration by Parts and by Rationalisation, Reduction	X	
11	REVISION.		

Note: Lessons 10 and 11 are intended for certain examinations only, and will be sent only to those students who are required by their syllabus to study the further methods of transformation, integration by parts and by rationalisation, successive reduction and decomposition into partial fractions which are discussed in these Lessons.

Wolsey Hall, Oxford

TRIGONOMETRY
INTER. GRADE R

SCHEME OF STUDY A

TEXT-BOOK

Loney's Plane Trigonometry, Part I.......................... ....
(See over-page for alternative Text-Book)

INSTRUCTIONS

Book-work: A certain amount of book-work is set each week, and must be thoroughly mastered.

Exercises: A list of examples is appended to each Lesson. The student should endeavour to do all these and should SEND IN TO HIS TUTOR FOR SOLUTION THOSE, AND THOSE ONLY, WHICH AFTER A FAIR TRIAL HE HAS FAILED TO SOLVE. COPY THE QUESTION IN FULL ON THE SPECIAL INQUIRY FORM (MENTIONING EXERCISE AND NO.).

N.B. THIS PART OF THE WORK MUST ON NO ACCOUNT BE NEGLECTED AS THE MERE WORKING OF OUR TEST PAPERS IS NOT ENOUGH IN ITSELF.

Test Paper: Send in for correction the Test Paper given in each Lesson.

NOTES ON INTERMEDIATE STAGE

A Student's success in this branch of Mathematics depends largely upon an accurate knowledge of the formulae. It is a good plan to have a small note-book in which all formulae are to be entered as soon as learnt. They should then be well memorised.

Lessons I-V deal with all the elementary Trigonometrical formulae. Dozens of Examples must be worked. Most of them are very simple; but all help in fixing the formulae firmly in the mind.

Lessons VI-X deal with important practical applications. The numerical Examples in the Solution of Triangles are not difficult, but the utmost accuracy must be aimed at.

ARRANGEMENT OF LESSONS

Lesson	Subject	Text-Book
I.R.	Measurement of Angles. Trigonometrical Ratios. Values for Angles in Simple Cases	Chs. 1,2
II.R.	Simple Practical Examples Graphs of Functions	Chs. 3,4
III.R.	Trigonometrical ratios of angles of any size. General expression for all angles having given ratios	Chs. 5,6
IV.R.	Ratios of Sum and Difference of Two Angles	Ch. 7
V.R.	Ratios of Multiple and Sub-multiple Angles	Ch. 8
VI.R.	Sides and Angles of a Triangle	Ch. 12
VII.R.	Logarithms. Principle of Proportionate Parts	Chs.10,11
VIII.R.	Solution of Triangles	Ch. 13
IX.R.	Heights and Distances. Circles connected with a Triangle	Chs. 14,15
X.R.	Trigonometrical Ratios of small angles. Area of Circle. Simple Inverse Functions	Chs. 17,18
XI.R.	Revision with Specimen Examination Paper	
XII.R.	Second Specimen Examination Paper with Model Answers to First Examination Paper	
XIII.R.	Model Answers to Second Examination Paper	

I.A.....Hyperbolic Functions
I.B.....Model Answers
I.C.....Complex Quantities, De Moivre's Theorem
I.D.....Model Answers

(A Textbook is not essential with these Lessons, reference may however be made to: LONEY. PLANE TRIGONOMETRY PT II......C U.P. Or PAGE-ALGEBRA Ch.XI, pp.222-231

/P. T. O. - Important

ALTERNATIVE TEXT-BOOK

Students unable to obtain Loney's book will find that

Siddons & Hughes: Trigonometry (Parts. I-III)........C.U.P.

is an excellent alternative, in many ways more modern in its approach. (Only Parts I & II need be obtained if the Special Lessons are not included in your programme of Lessons).
The Lessons of the Course are very full so that the Course can be followed with this alternative text-book.
To help you further, the reading chart below shows the portions of Siddons & Hughes to be read with each Lesson, and the exercises to be worked.

Not all the exercises mentioned need be worked: you should attempt as many as your time allows.

Lesson	Siddons & Hughes	Exercises in S.& H.
I.R.....	Ch. 9, paras.1,2 ch. 1, paras.1-7 ch. 2, paras.1-3	Ia, b, c, d. IIA; IXa, b;VIa,1-33
II.R....	Ch. 2, paras.4-6 ch.11, paras.2,8	IIc, ; Ve; XIb, d
III.R...	Ch. 5, paras.1-3,8 ch.10, paras.1-8	Va, b Xb, c, d.
IV.R....	Ch. 7, paras.1,2,5 ch. 8, paras.1-3	VIIa, b VIIIa, b.
V.R.....	Ch. 4, para.3 ch. 7, paras.6-8 Note on Angles 18° & 36°	VII VIIh (1-22)
VI.R....	Ch.3 ch.4 (omit paras.3,5) ch.12, paras.1-3	IIIa-g XIIa
VII.R...	This Lesson may be used only by students using Loney. The material on Logarithms is assumed to be known; the Proportional Part Method can be ignored. Devote your time on more exercises on the subjects of Lesson VI.R.	
VIII.R..	As for VI.R	More exercises on Lesson VI.R
IX.R....	Ch. 2, para.8 ch. 4, para.5 ch.12, paras.4-8	IIf; IVb; XIIc, d ; XIIIb

Special Lessons..................Part III, chs.XIV, XV.

WOLSEY HALL
OXFORD

CO-ORDINATE GEOMETRY.F

SCHEME OF STUDY.F

TEXT-BOOK

Loney: Elements of Co-ordinate Geometry, Part I......Macmillan.

Students who are not required to study beyond Lesson 15/F may use instead:

Loney: Straight Line & Circle.........................Macmillan.

This is simply a separate publication of the first nine chapters of the larger work, and the pages have exactly the same sequence and content in the two books.

ARRANGEMENT OF LESSONS

Lesson	Subject	Text-Book Chapter
1/F	Cartesian and Polar Co-ordination	I & II
2/F	Areas of Triangles and Quadrilaterals	II
3/F	Loci. Equations of Loci	III
4/F	The Straight Line Equations	IV
5/F	Angle between Straight Lines	IV
6/F	Length of Perpendicular. Bisectors of Angles	IV
7/F	Equations Representing Two or More Straight Lines	VI
8/F	Transformation of Co-ordinates	VII
9/F	The Circle	VIII
10/F	Tangents and Normal Equation	VIII
11/F	Intersection of Straight Line and Circle. Discussion of Tangents	VIII
12/F	Intersection of Two Circles. Radical Axis	IX
13/F	Miscellaneous Problems. Revision of Bookwork.	
14/F	Final Hints and EXAMINATION PAPER.	
15/F	SPECIMEN ANSWERS TO EXAMINATION PAPER.	
16/A	Properties of Parabola, including tangents	X
17/A	Further Properties of Parabola	X
18/F	Elementary Properties of Ellipse	XII
19/F	Elementary Properties of Hyperbola. Rectangular Hyperbola	XIII
20/F	REVISION. EXAMINATION PAPER.	
21/F	SPECIMEN ANSWERS TO EXAMINATION PAPER.	

For certain examinations the syllabus specifies additional items of study. The Supplementary Lessons listed below are intended only for students taking these examinations, and will be sent only to those students.

Lesson	Subject
22/F.....	Supplementary Lesson on Co-ordinate Geometry of Three Dimensions: the Straight Line, the Tetrahedron.
23/F.....	Supplementary Lesson on Co-ordinate Geometry of Three Dimensions: Co-ordinates and the Plane.
24/F.....	Supplementary Lesson: Revision of Co-ordinate Geometry of Three Dimensions.

WOLSEY HALL
OXFORD

CHEMISTRY
INTERMEDIATE

SCHEME OF
PRACTICAL WORK

INTRODUCTION

It is essential that students taking Intermediate or Advanced Level Chemistry should carry out a systematic course of practical work, mainly on qualitative and volumetric analysis. Arrangements should therefore be made for experimental work to be carried out in a laboratory under supervision, either regularly throughout the Course, or, alternatively, for concentrated periods during vacations. The appended essential series of experiments can be covered in a normal session (30 weeks), allowing a minimum evening or part-time period of 3 hours per week; it is, however, advisable to put in additional time where possible. Brief notes for individual experiments will be issued as a guide, subject to conditions in the laboratory and arrangements with the teachers. Normally, students should have already completed an elementary Course at G.C.E. Ordinary Level.

Candidates may be required by their exam. regulations to bring to the Practical Examination their original laboratory note books, for inspection by the Examiners. You should ascertain whether this requirement is included in your particular regulation; whether or not this is so, all practical work should be carefully recorded in a stiff-backed note book which can be obtained from Wolsey Hall. Each experiment should be dated and the teacher's initials obtained.

Repeatedly during the Course of Practical Work, students should familiarise themselves with principles of analysis. A/Level students may be required to analyse four radical mixtures, or to analyse single substances only. Check with your syllabus what your requirements are.

Much of the practical analytical work detailed will be helpful in connection with the theoretical Lessons, but, according to individual requirements, the work can be modified or expanded to include some preparations for practical organic chemistry.

TEXT-BOOKS

A good text-book of qualitative and volumetric analysis is essential. Notes on analytical tables are helpful, but a book detailing the reactions of the individual metals and acids, in addition to the analytical tables and their underlying principles, will be invaluable to the beginner.

The following text-book for Intermediate and A/Level Practical Examinations, can be used:

1. Bruce & Harper: Practical Chemistry.....................Macmillan

This is one of several practical textbooks available and if you already have another you should be able to continue with it. The general directions to be given will, therefore, make no specific references, but students will have no difficulty in finding the substance of individual experiments in the chosen text-book. The general principles of analysis are also clearly described in the Analytic Section of Lowry and Cavell (Chs. XXVIII-XXIX). A very detailed and particularly helpful little book for the student, giving full guidance as to exam. room technique, setting out of work, calculations, etc., and containing tables of logs and antilogs, is

Skellon: A concise Scheme of Volumetric Analysis...........Pitman

Other very helpful little books are:

Spencer: Qualitative Analysis Tables........................Blackie
Breuer: Practical Chemistry..................................Blackie

ARRANGEMENT OF EXPERIMENTS

Expt. No. — Subject of Expt.

I. PRELIMINARY

1......Equivalent of magnesium, copper or zinc by conversion to oxide. Equivalent of magnesium or zinc by displacement of hydrogen.

II QUALITATIVE ANALYSIS

2......Chemical manipulation. Preliminary dry tests with known substances.
Reaction of Metals:
Reactions of individual metals, using appropriate solutions, should next be carried out, group by group, and noted. For each group, students should then carry out analysis on a test solution for that group (single radical or mixed radicals).

3......Reactions of Group I Metals (silver, lead, mercury). Test solution.

4......Reactions of Group IIa Metals (mercuric salts, bismuth, copper, cadmium). Test solution.

5......Reactions of Group IIb Metals (tin, antimony, arsenic). Test solution. (Avoid tests such as Marsh's test except under supervision of a teacher).

6......Reactions of Group III Metals (iron, aluminium, chromium). Test solution.

7......Reactions of Group IV Metals (zinc, manganese, nickel, cobalt). Test solution.

8......Reactions of Group V Metals (Barium, strontium, calcium). Test solution.

9......Reactions of Group VI Metals (sodium potassium, magnesium, ammonium). Test solution.
Reaction of Acid Radicals:
Reactions of acid radicals should first be carried out on known substances. For each group a test analysis is then undertaken.

10.....Reactions of acid radicals detected by warming with dilute hydrochloric acid. (Carbonate, sulphite, nitrite, thiosulphate, sulphide, etc.). Confirmatory tests. Test substances.

11.....(a) Reactions of acid radicals detected by warming with concentrated sulphuric acid. (Nitrate, chloride, bromide, iodide, oxalate, etc). Confirmatory tests. Test substances.
(CAUTION: Beginners should not carry out experiments involving concentrated sulphuric acid except under supervision of a teacher).
(b) Reactions of acid radicals precipitated by silver nitrate in presence of dilute nitric acid. (Chloride, bromide, iodide). Test substances.

12.....Reactions of acid radicals precipitated by barium chloride in presence of dilute hydrochloric acid. (Sulphate).
Reactions of other acid radicals, e.g. precipitated by silver nitrate or barium chloride in neutral solution (e.g. phosphate, phosphite, borate, chromate). Test substance.

13.....Systematic analysis of single substance or four radical mixtures. (To continue throughout the Course).

III VOLUMETRIC ANALYSIS

Acidimetry and Alkalimetry:

14.....Simple titration of acid and alkali.

15.....Preparation and use of standard sodium carbonate solution. Determination of potassium hydroxide solution.

16.....Preparation and use of standard oxalic solution. Determination of acetic acid.

Oxidation and Reduction:

17.....Standardisation of potassium permanganate solution by ferrous acid. Determination of hydrogen peroxide.

18.....Standardisation of potassium permanganate solution by oxalic acid. Determination of hydrogen peroxide.

19.....Standardisation of potassium permanganate by use of an oxalate. Determination of a ferrous iron solution.

20.....Standardisation of sodium thiosulphate by potassium dichromate. Determination of iodine.

21.....Standardisation of sodium thiosulphate by copper sulphate.

22.....Use of standard sodium thiosulphate in determination of available chlorine.

23.....Determination of potassium dichromate solution using ferrous salts. Estimation of ferric iron by potassium dichromate.

24.....Standardisation of iodine solution by arsenious oxide. Determination of sodium thiosulphate.

Precipitation:

25.....Standardisation of silver nitrate solution by sodium chloride. Determination of a neutral chloride, bromide or iodide.

26.....Standardisation of a solution of potassium thiocyanate by silver nitrate. Determination of an acid chloride by Volhard's method.

27.....Revision experiment (Selected) - e.g. estimation of ammonia in ammonium salts.

28.....Revision experiment (Selected) - e.g. estimation of oxalic and sulphuric acids in a mixture of both.

29.....Revision experiment (Selected) - e.g. estimation of hydro chloric and nitric acids in a mixture of both.

30.....Revision Test. Complete analysis of a four radical mixture, volumetric test involving standardisation of a solution and using it to determine strength of the given test solution.

ADDITIONAL EXPERIMENTS: FOR CERTAIN EXAMS ONLY

32.....Determination of the Iodine Value of Olive Oil, using Wijs' solution.

33.....Some simple organic preparations and reactions.

34.....Simple reactions and tests - Properties of Benzaldehyde (Expt. 179, Lowry and Cavell); Properties of benzoic acid (Expt. 180, Lowry and Cavell).

WOLSEY HALL
OXFORD

CHEMISTRY
INTERMEDIATE

SCHEME OF STUDY

TEXT BOOK

Lowry & Cavell: Intermediate Chemistry.................Macmillan.

PRELIMINARY INFORMATION

The Course covers the requirements of the Advanced Level examination and other examinations of a similar standard. The Lessons are planned on a logical development of the subject, suitable for students with a knowledge of chemistry up to Ordinary or School Certificate level, and with each Lesson guidance to reading from appropriate parts of the text-book is given. In order to secure maximum value from the Course, students should systematically make their own notes, with drawings of apparatus, in a good loose-leaf notebook, utilising information from both Lessons and text-book.

Particular attention is drawn to the necessity for method in setting out preparations and reactions and to the need for understanding fundamental principles such as oxidation and reduction. Much unnecessary memory work will thus be saved.

A Scheme of Study, with instructions for Practical Work, is issued separately.

ARRANGEMENT OF LESSONS

Lesson	Subject	Text-Book
	SECTION I. GENERAL AND THEORETICAL	
I.	Laws of Chemical Combination; Atomic and Molecular Theories	Ch. I-III
II.	Molecular, Equivalent and Atomic Weights	Ch. II, III, IV
III.	Atomic Structure and the Periodic System; Electronic Theory of Valency	Ch. V, VI, VIII
	SECTION II. NON-METALS	
IV.	Hydrogen, Water, Hydrogen Peroxide Oxidation and Reduction	Ch. X
V.	Oxygen, Oxides, Ozone	Ch. XIX
VI.	Fluorine and Chlorine	Ch. XXI
VII.	Bromine and Iodine	Ch. XXI
VIII.	Sulphur and Compounds	Ch. XX
IX.	Nitrogen and Compounds	Ch. XVI
X.	Phosphorus, Arsenic, Antimony, Bismuth	Ch. XVII-XVIII
XI.	Carbon, Silicon, Boron	Ch. XIII-XIV
	SECTION III. PHYSICAL CHEMISTRY	
XII.	States of Matter; The Gaseous State; The Crystalline State	Ch. XXXIII-XXXV
XIII.	Solution; Osmosis	Ch. XXXVI-XXXVII
XIV.	Molecular Weights in Solution	Ch. XXXVIII
XV.	Thermochemistry; Chemical Equilibrium; Law of Mass Action	Ch. XL-XLI
XVI.	Electrolysis; Conductivity of Electrolytes	Ch. XLIV
XVII.	Electrolytic Equilibria, Hydrolysis; Theory of Indicators	Ch. XLV

SECTION IV. THE METALS

Typical Series

Transition Series.

SECTION V. ORGANIC CHEMISTRY

NOTE: The Lessons below are supplementary to this Course and are intended only for students whose examination syllabus requires study of certain items not treated in the main Course. Accordingly, students who are not specifically instructed to do the additional Lessons should ignore them as being outside their syllabus.

SECTION VI. ADDITIONAL LESSONS FOR CERTAIN EXAMS. ONLY.

WOLSEY HALL
OXFORD

ZOOLOGY/A

SCHEME OF STUDY

TEXT-BOOK

All students will need to possess:

Grove and Newell: Animal Biology............University Tutorial Press.
You must get the most recent edition of this book. References are to the 7th edition (1966).

Practical dissection books will also be required (see Scheme of Practical Work attached).

SUPPLEMENTARY READING

Darwin: The Origin of Species...............................O.U.P.,
Ford: Mendelism and Evolution.....................Methuen Monograph,
Auerbach: Notes for Introductory Courses in Genetics...Oliver & Boyd,
British Museum (Nat.Hist.) booklet "Evolution"..from the Natural History Museum, South Kensington, London.
Simpson: The Meaning of Evolution............................O.U.P.,
Sankey: A Guide to Field Biology..........................Longmans,
Dowdeswell: Animal Ecology................................Methuen,
Lorenz: King Solomon's Ring.
A Dictionary of Biology, e.g. the Pelican by Abercrombie & Johnson.

Any 'A' level textbooks of Biology may be useful for reference. Various books in the Collins "New Naturalist" series may be relevant to your ecological studies.

Supplementary books are not essential: the above list is to suggest advantageous further reading. Your local public library can obtain these books for you.

PRELIMINARY INFORMATION

Syllabus: This is a comprehensive Course designed to cover G.C.E. Advanced Level and Higher School Certificate requirements. [The Special Paper, where this is separate, requires the same syllabus but expects both deeper and more general consideration of the subject].

OBTAIN A COPY OF YOUR OWN SYLLABUS: the different examinations differ in detail, and syllabuses change from year to year. You may be able to omit some of the topics included in the Course for the benefit of other syllabuses. Overseas students should note that they must study animals obtainable in their own country, making substitutions as necessary for the types discussed here.

Approach: Biology, the study of living things, can be separated into Zoology (the study of animals) and Botany (the study of plants). However, in concentrating your studies on the animal kingdom, the interdependence of plants and animals must not be forgotten. All animals are ultimately dependent on plants for food, since only green plants can trap the energy of sunlight and store it in a form which plants and animals can use. The distribution of animals is thus dependent on the occurrence of plant food (and plants in turn depend upon animals in various ways).

Throughout this Course the background fact of Organic Evolution should be borne in mind. All living things have been produced by other living things. Millions of years ago, when life began on earth, living things were very simple indeed. Since then, more and more complicated plants and animals have evolved very slowly, by gradual changes down the generations. Examples of very simple forms of life still exist side by side with the most highly evolved organisms (ourselves in the

animal kingdom, and flowering plants in the plant kingdom). Although there is only one Lesson specifically devoted to Evolution, the whole Course is designed to illustrate this process.

First, the very simplest forms alive today are introduced: the single-celled animals. Then animals of gradually increasing complexity are discussed, by the study of selected "types" which represent distinct levels of organisation. The most highly evolved animals (Vertebrates, and in particular Mammals) are studied in detail, and there is here some comparative treatment of the various life processes, as revision. There follows a number of general topics: the structure of cells and tissues, animal behaviour, early development, evolution, classification and genetics, and animals in relation to their environment including Man.

Each Lesson includes a Test Paper, to give you practice in answering questions taken from examination papers. You need not answer these questions under strict examination conditions (until the Specimen Examination Paper at the end) but do keep your answers down to the length of an examination answer (you have roughly half-an-hour for each answer). Note the following very important points:-

1. READ THE QUESTIONS CAREFULLY AND ANSWER EXACTLY WHAT THAT PARTICULAR QUESTION ASKS. Plan your answer, and present your facts precisely and economically. Irrelevance can only lose you marks.

2. GIVE DIAGRAMS wherever possible to illustrate your answers. No description of structure is complete without a diagram. Draw firmly and boldly with a sharp pencil, without shading or sketching. Label your diagram clearly.

ARRANGEMENT OF LESSONS

Lesson	Subject	Reading Grove & Newell, 7th ed.
1	THE CHARACTERISTICS OF LIVING THINGS. Differences between Plants and Animals, Amoeba, Chlamydomonas, Euglena.	Ch.I,pp.1-9. Ch.IV,pp.71-78, 111-116.
2	Further Examples of PROTOZOA. Paramecium, Plasmodium, Monocystis, Trypanosomas, Peranema,Polytoma, Volvox, Feeding Methods in General, Classification of Protozoa.	Ch.IV, pp.78-111.
3	MULTICELLULAR ORGANISMS: Coelenterates, Hydra, Obelia.	Chs.V,VI,pp.127-156.
4	PLATYHELMINTHES: Introductory Sections, Planarians, Trematodes, Cestodes.	Ch.VII,VIII.
5	PARASITISM: Adaptations to Parasitism, Biological Success. Nematodes; Ascaris, Ancylostoma	Ch.IX, Ch.X.
6	COELOMATES: Metameric Segmentation, Annelids, Polychaetes (Nereis), Oligochaetes (Earthworm).	Ch.XI, Ch.XII.
7	ARTHROPODS in General, Astacus, Periplaneta.	Ch.XIII,pp.268-331.
8	OTHER INSECTS: The Butterfly, Metamorphosis, The Hive Bee, The Aphis, The Mosquito, The Housefly, MOLLUSCA: The Snail (Helix).	Ch.XIII,pp.231-344, Ch.XIV.
9	CHORDATES: Amphioxus, Vertebrates, The Five Classes of Vertebrates.	Ch.XV, Ch.XVI, Ch.XVII,pp.390-391.

Lesson	Subject	Reading (Grove & Newell, 7th ed.)
10....	DOGFISH, FROG AND RABBIT: External Features, The Skin, Temperature Regulation, Metamerism, A Teleostean Fish (Gadus). Adaptations to Flight in Birds.	Ch.XVII, pp.400-416.
11....	THE SKELETON, The Vertebral Column, The Skeleton of the Dogfish, Frog, Rabbit: Muscles, Teeth.	Ch.XVII, pp.417-459, 465-471.
12....	THE ALIMENTARY CANAL in the Dogfish, Frog, Rabbit: Nutrition, Enzymes, Food Tests.	Ch.XVII, pp.481-510.
13....	THE VASCULAR SYSTEM: The Basic Plan of the Vertebrate Circulation, Single and Double Circulations, the Heart, The Arterial Arches, Other Arteries, The Venous System, Blood and Lymph.	Ch.XVII, pp.510-540.
14....	RESPIRATION, External Respiration in the Dogfish and Teleosts, The Frog, The Rabbit, Tissue Respiration.	Ch.XVII, pp.540-559.
15....	THE NERVOUS SYSTEM, The Brain, The Spinal Cord and Nerves, The Cranial Nerves, The Eye, The Ear, Other Sense Organs.	Ch.XVII, pp.559-632.
16....	THE RENAL AND REPRODUCTIVE SYSTEMS, The Renal System, The Reproductive System, Excretory Systems in General, Osmotic Regulation, The Endocrine Organs.	Ch.XVII, pp.633-672.
17....	CYTOLOGY, Protoplasm, Cell Structure, Cell Division, Mitosis, Meiosis, Fertilisation.	Ch. I, pp.9-27, Ch.II, Ch.XVIII.
18....	HISTOLOGY of Vertebrates: Epithelial Tissues, Connective Tissues, Muscular Tissues, Nervous Tissue, The Structure of Some Organs [Stomach, Intestine, Liver, Pancreas, Kidney, Testis, Ovary].	Ch.XVII, pp. 391-399, 459-465, 472-480, 533-540, 590-603, 648-655.
19....	ANIMAL BEHAVIOUR, Behaviour and the Evolution of the Nervous System, Instinctive Behaviour, Intelligence and Learning, Parental Care.	Pp.116-120, 138-142, 164-168, 257-259, 299-304, 327-329, 343-344, 356, 403-407.
20....	EMBRYOLOGY: Introduction, Cleavage, Differentiation, Gastrulation, Organ Formation, Age of Hatching, Amphioxus, The Frog, Organisers.	Ch.XIX, pp.682-731.
21....	EMBRYOLOGY: The Chick, The Embryonic Membranes, The Development of Mammals.	Ch.XIX, pp.731-778.
22....	EVOLUTION: What is Evolution? How do we know that it happened? How did it happen?	Ch.XXI.
23....	PRINCIPLES OF CLASSIFICATION, Evolution and Phylogeny, The System of Classification, Animal Phyla.	Ch.III, Parts of Ch.XXI, parts of Ch.XXIII.

Lesson	Subject	Reading (Grove and Newell, 7th ed.)
24....	GENETICS: Mendel's Laws, Dominance, The Mendelian Ratio, The Cytological Basis of Genetics, Sex Determination, Genetics and Evolution.	Ch.I,pp.9-27, Ch.XX.
25....	ECOLOGY: The Interdependence of Plants and Animals, The Distribution of Plants and Animals, Animal Communities, Modifications by Man, The Nature Conservancy.	Ch.XXII.
26....	ECOLOGY: THE RELATION OF ANIMALS TO MAN: Useful Organisms and Pests, Biological Control of Pests, Chemical Control of Pests, The Conservation of Man.	
27....	REVISION AND EXAMINATION PAPER.	
28....	SPECIMEN ANSWERS TO EXAMINATION PAPER.	

JANET MOORE, M.A.,Ph.D.(Cantab.)

P.T.O.

ZOOLOGY/A

SCHEME OF PRACTICAL WORK

BOOKS RECOMMENDED

FOR DISSECTIONS:

Whitehouse & Grove:	Dissection of the Earthworm, Dissection of the Cockroach, Dissection of the Dogfish, Dissection of the Frog, Dissection of the Rabbit.	Univ. Tutorial Press

Rowett's Dissection Guides (Murray) for Dogfish, Frog, Rat and Rabbit may be used as alternatives or complements to Whitehouse & Grove.

FOR GENERAL PRACTICAL WORK:

Marshall & Hurst: Practical Zoology..................John Murray.

The little books by Whitehouse & Grove are essential for your practical work; the large single volume by Marshall & Hurst, while not essential, will be found very useful. It contains a valuable introduction on laboratory methods besides considerable detail about the types you will be studying in the Course.

PRELIMINARY INFORMATION

It is most important that practical work should be performed regularly and systematically, including the dissection of certain specified types and the general examination of representatives of all groups of animals. You should try to put in 3 hours practical work each week; any additional time which you can give to practical work will prove very valuable. If that is at all possible, you should make arrangements for the use of a laboratory, preferably under supervision. In this way you will be most likely to have access to a microscope and the numerous microscope slides which have to be studied from time to time, as well as to other general facilities.

But your work should not be confined to the laboratory. It is essential that you should make investigation and observation of the form and habits of the animals in at least one particular habitat - e.g. a pond, a stream, the sea-shore, etc. - or of one particular common group of animals. Note carefully the directions for practical work in your own syllabus.

Laboratory Notebooks MUST be kept, and kept carefully, in which to enter records of all practical work undertaken. These Notebooks MUST BE PRESENTED AT THE PRACTICAL EXAMINATION. For your purpose, you will require stiff-backed notebooks, preferably with blank drawing pages and lined writing pages alternating. Keep separate books for field work, laboratory dissections, and physiology. (See page 4).

Drawings should be large and clear, with no unnecessary shading. Use single rather than double lines wherever possible, and do not use coloured pencils too frequently. What is wanted is a clear and neat diagram, not a work of art. Labelling should always be horizontal to facilitate reading at a glance, and lines of indication should be drawn in such a way that they do not become confused with the lines of the actual drawing. Print the name of the animal on the top of the page, state whether the dissection is dorsal or ventral, or whether the study is of a whole specimen. Make a drawing of what you actually see, rather than copy a diagram or drawing in a book: in this way you will learn more surely.

On the writing pages the details of the experiments should be set out in a systematic pattern, with clear headings, e.g.:
Aim....(To Observe...; To Investigate...; To Confirm....)

1. Method.....(N.B. give the reason for your procedure.)
2. Observations
3. Conclusion.

If any difficulties are encountered, make a note of them for future reference. Let the details of the experiment face the drawing which relates to it. Date each experiment.

Finally, before beginning any practical work, see that you have read your notes on the subject, or the instructions in your practical text-books, so that you have a definite idea what you are setting out to find or to prove.

Instruments: For dissections you will require the following instruments:

1. One pair large, straight dissecting scissors
2. One pair small, straight dissecting scissors
3. One large metal scalpel
4. One small metal scalpel
5. One all-metal seeker with rounded end
6. Two mounted needles
7. One fine metal scalpel with a very narrow blade
8. One pair strong blunt forceps, 5" long
9. One pair medium pointed forceps, 4" long
10. One pair very fine pointed forceps
11. One aluminium section-lifter
12. One camel-hair paint-brush
13. One pipette
14. One pair dividers
15. One watchmaker's eyeglass or hand lens.

Instruments must be kept very clean; and if you are not using them for some time you should give them a thin coating of vaseline. To get good results, scalpels and scissors must be kept sharp. Never use them to cut anything unnecessarily. Learn to use an eye-glass for all examinations of the small animals. For the examination of sections you must have access to a microscope. After a little practice you should be able to use both the eye-glass and the microscope with both eyes open.

Sources of Materials

FOR ZOOLOGICAL & BOTANICAL SPECIMENS, MODELS, SKELETONS:
E. Gerrard & Sons, 61, College Place, Camden Town, London, N.W.1., England.

FOR FRESHWATER SPECIMENS:
Freshwater Biological Laboratory, Ferry House, Far Sawrey, Ambleside, Westmorland, England.

FOR MARINE SPECIMENS:
Marine Biological Laboratory, Plymouth, Devon, England.

FOR MICROSCOPES & ACCESSORIES:

Flattres & Garnet, Ltd., 309, Oxford Road, Manchester, England.
C. Biddolph & Co., Green Belt, London Rd., Merstham, Surrey, England.
Baird & Tatlock, Ltd., 14-17, Cross St., Hatton Gardens, London, E.C.1. England.

Philip Harris & Co., 144, Edmund St., Birmingham, England.
Chas. Baker, 244, High Holborn, London, W.C.1., England.

ARRANGEMENT OF PRACTICAL WORK

The practical work is arranged to run as far as possible parallel with your theoretical studies in the Lessons of your Course. In each Lesson further instructions will be given as to the work to be done in connection with that Lesson. In addition to references to the essential practical text-books by Whitehouse & Grove, references to Marshall & Hurst will sometimes be given: these latter are for your convenience if you are able to adopt this book in addition to the text-books.

While it is best to defer practical work until you have done your theoretical studies, you may wish to start your main dissections (dogfish, frog and rat or rabbit) before you get to Lessons 10-16. With the aid of Whitehouse and Grove, this should be perfectly possible. The list of slides given here will enable you to order what you require, in advance. Field work must be fitted in at appropriate times of the year, and cannot be left until the Ecology Lessons at the very end of the Course.

Your own syllabus will give you a useful indication of the practical work expected. Omit from the following list those animals not required by your syllabus.

Lesson	Practical Work	Materials Required
1..... 2.....	Examination of living examples and stained slides of various Protozoa (see your own syllabus).	Amoeba, Euglena, Chlamydomonas, Paramecium, Monocystis, Plasmodium and any others in your syllabus: obtain stained slides, and living specimens if possible.
3.....	Hydra and Obelia.	Slides of Hydra, T.S. and L.S. with buds and gonads. Obelia polyps, blastostyles and medusae.
4.....	Planariea, Fasciola and Taenia.	Slides of these flatworms: some larvae of Fasciola: embryo, cyst, scolex and mature proglettis of Taenia.
5.....	Nematodes.	Whole mounts of small Nematodes. T.S. Ascaris.
6.....	Dissection of the Earthworm (and possibly Nereis also).	Slides of T.S. Lumbricus at various levels. Head (with jaws) and parapodia of Nercis.
7.....	Dissection of the Cockroach (for some, also the Crayfish).	Mouth parts and tracheae and legs of Cockroach: various appendages of Crayfish.
8.....	Butterfly, Bee, Aphis, Mosquito, housefly. Dissection of the snail (for some.)	Larval and adult stages of the insects required.
9.....	Amphioxus.	Slides of sections through pharyngeal and intestinal regions of Amphioxus
10-16...	Dissection of Dogfish, Frog and Rat or Rabbit. Also their skeletons, and the skull of a dog.	Preserved Dogfish, Frog fresh if possible. Rabbit or rat. Also, the following bones, for each (unless otherwise indicated): Vertebrae (all kinds), Skull of Dog, pectoral and pelvic girdles, limb bones, sternum and ribs of mammal, fins of dogfish.

Lesson	Practical Work	Materials Required
10-16 (cont.)		Teeth of various mammals.
	Food tests and simple experiments on digestion and respiration and reflex action.	
18.....	Histology of Tissues and Organs.	Slides of epithelial tissues (pavement, cubical, columnar ciliated and glandular). Connective tissues (arcolar, fibrous and elastic, cartilage, bone, blood). Muscle (unstriated, striated, cardiac). Nerve and Spinal Cord. Also of the following organs: Skin, stomach, liver, intestine, pancreas, kidney, testis, ovary, thyroid gland.
20-21..	Embryology of Amphioxus, Frog, Chick and Rabbit.	External view of all stages in frog development from fertilisation to metamorphosis: stages of gastrulation and neurulation in Amphioxus and Frog seen in T.S. and L.S: 1st, 2nd and 3rd day development stages of the chick, in sections and whole mounts. Embryonic membranes in chick and mammal.
25-26..	Ecology. Your own field study of a particular habitat and/or a particular group of animals.	

IMPORTANT NOTE ON LABORATORY BOOKS

Most Examinations have a regulation that Laboratory Notebooks should be certified by a qualified supervisor. This emphasises the importance of making arrangements for the use of a laboratory, for the supervisor can then be asked to certify that you have done the work recorded in your Laboratory Notebook. Wolsey Hall cannot undertake this certification of your practical work.

JANET MOORE, M.A.,Ph.D.(Cantab.).

ZOOLOGY/A

WOLSEY HALL
OXFORD

LESSON 24

SET WORK

SUBJECT: GENETICS: Mendel's Laws, Dominance, The Mendelian Ratio, The Cytological Basis of Genetics, Sex Determination, Genetics and Evolution, Nucleic Acids.

READING: Grove & Newell, Ch.I, pp.9-27, Ch.XX. [Ford, "Mendelism and Evolution" (Methuen) is also recommended. Auerbach, "Notes for Introductory Courses in Genetics" (Oliver & Boyd) may be useful.]

N O T E S

GENETICS

The Link Between Generations: All living things are derived from other living things; there is no such thing as "Spontaneous Generation" of life from inanimate matter. All organisms develop from the division of cells which previously formed part of one or two parent organisms. Therefore the cells derived from the parent(s) must contain hereditary factors (called GENES) which determine the specific characteristics of the offspring. Genetics is the study of heredity; the study of the mechanism by which parents transmit characteristics to their offspring.

The Two Effects of Genes:

1. THE BASIC SIMILARITY between parent and offspring is ensured, so that offspring are recognisably of the same species as their parents.
2. VARIATIONS are introduced. This only applies to sexual reproduction involving two parents: in asexual reproduction the offspring are identical to their parent. In sexual reproduction, however, two cells fuse to form a zygote, and in this way hereditary factors from the two parents are combined.

Two Lines of Study have been complementary in providing our present knowledge of Genetics. The first is the study of plant and animal breeding, as initiated by Mendel: the second is cytological studies of the cell nucleus.

1. MENDEL did for Heredity what Dalton had done for Chemistry: he formulated an "atomic theory". He performed experiments on cross-breeding garden peas, and deduced that hereditary factors are constant units which are handed down unchanged from parent to offspring. The practical results led Mendel to consider the plant as an assemblage of a vast number of separate hereditary factors, instead of the earlier picture (such as Darwin himself had) of "blending" inheritance. Isolated pairs of factors behaved in the manner predicted, and Genetics became a quantitative study, accessible to mathematical treatment. Mendel's Laws are discussed below.
2. CELL STUDIES then identified Mendel's "hereditary factors" as "genes" borne longitudinally on the chromosomes in the nucleus of every cell. Acting in every cell, these genes determine the characterestics of the organism. At mitotic cell division, genes are divided into two, and daughter cells have exactly the same genes as the parent. At meiosis, however, the chromosome number is halved, and only half the genes are present in each gamete. Thus genes are shuffled at every mating.

MENDEL'S LAWS

Mendel used a species of self-pollinating pea. He selected a certain characteristic (e.g. the form of the seeds or their colour or the height of the plant) and artificially cross-pollinated a plant with pollen from peas which differed in the chosen characteristic. The offspring of this cross (called the first filial generation, F_1) were then crossed with each other or allowed to self-pollinate, and the characteristics of the second filial generation (F_2) were noted. Alternatively, the F_1 were in some experiments "back-crossed" with the parental generation (P).

From experiments of this type, Mehdel formulated two Laws:

1. The Law of Segregation: Hereditary factors exist as distinct and separate units. These units occur as "allelomorphic pairs", the two units of each pair representing two contrasted characteristics. Further, when gametes are formed, only one factor of any pair can be represented in a single gamete.

   This Law has been verified so frequently and so invariably that it can be accepted without question.

2. The Law of Independent Assortment: The behaviour of the factors in any one allelomorphic pair is independent of the behaviour of any other allelomorphic pairs: all the hereditary factors segregate independently, at gamete formation.

   This Law is not universally true: exceptions are caused by the phenomenon of "linkage", to be explained shortly.

DOMINANCE

When the two factors in an allelomorphic pair are both present, the effect of one may mask the effect of the other. For example, in the "four-o-clock" plant, the factors for redness of flower and the factors for whiteness of flower exert an equal effect, when both are present: there is no dominance, and the flower is pink. This pink flower is called a "heterozygote" since the zygote must contain two different factors for this character: factors conferring redness and factors conferring whiteness. When this pink flower forms gametes, the "pink" is resolved according to Mendel's First Law: the factors segregate and each gamete carries either factors for redness or factors for whiteness, never a blended "pink".

However, the factors for red eye-colour and white eye-colour in the fruit fly Drosophila (a favourite genetic material for Zoologists) take effect differently. Here red eye-colour is "dominant" to white, which means that in the heterozygote, where both factors are present, the eyes are red. In appearance, this heterozygote is indistinguishable from a red-eyed "homozygote" which contains factors for red eye-colour only. Further crossing, however, reveals that the red-eyed heterozygote can produce gametes bearing the factor either for red or for white eye-colour, just like the pink-flowered heterozygote of the "four-o-clock". The red and white homozygotes can only produce gametes bearing the factor for red or for white respectively. The two sorts of red-eyed Drosophila are said to have the same "phenotype" (appearance) but a different "genotype" (genetic constitution). In the Drosophila example, the factor for red eyes is said to be "dominant" and the factor for white eyes "recessive". The recessive factor is never obliterated just because its effects are masked in a heterozygote: it reappears in the next generation.

THE MENDELIAN RATIO

Mendel found that when peas with two characteristics are crossed, and the first filial generation "selfed", the two characteristics appear in the ratio of 3 : 1 in F_2 (or 1 : 2 : 1 if there is no dominance). For example, if the parents are tall and short peas, and if the tallness factor is dominant to the shortness one, all the gametes of the homozygote tall parent must carry the tallness factor; and all the gametes of the homozygote short parent must carry the shortness factor. If all possible combinations of gametes are worked out, it is seen that all the F_1 will be heterozygotes, apparently tall but with the recessive factor for shortness.

P............	Tall pea	×	Short pea	
Gametes	T	T	s	s
F_1	Ts	Ts	Ts	Ts

Then if these heterozygotes are self-pollinated, or crossed with each other, the possibilities are as follows:

F_1	Ts	×	Ts	
Gametes......	T	s	T	s
	TT	Ts	Ts	ss
F_2	Tall	Tall	Tall	short
	Homozygote	Heterozygote		Homozygote

The probability is, therefore, that in F_2 there will be three tall peas to every one short pea. This is called the MONOHYBRID RATIO.

Note carefully that this is only the probable distribution, assuming that each gamete is equally likely to fuse with any other. With a small number of offspring, the 3 : 1 ratio will not be found exactly. With a large number, however, this theoretically deduced ratio is found to be remarkably well borne out.

Similarly, when two allelomorphic pairs are studied, there is a corresponding ratio of the resulting combinations in the F_2 generation. This is called the DIHYBRID RATIO.

9 double dominant : 3 of each type of one dominant with one recessive : 1 double recessive

See diagrams in Grove & Newell.

You should now read Grove & Newell, pp. 779-790. These sections of the textbook should now be quite clear, and will fill in the above outline of Mendelism.

THE CYTOLOGICAL BASIS OF GENETICS

The second main line of study has provided a cytological basis for the laws formulated by Mendel: the "genes" borne on the chromosomes have been identified as Mendel's hereditary factors.

It is simpler, though less logical, to state this theory first, and explain afterwards the evidence from which it is derived.

Genes and Mitosis: The vast numbers of genes are arranged along the chromosomes lengthwise. When the chromosomes split longitudinally at mitosis, the genes reproduce themselves so that each chromatid has exactly the gene-content of the parent chromosome, and therefore the daughter cells have exactly the same genes as the parent - each cell in an organism contains identical genes. This power of self-reproduction of genes is a property of nucleo-proteins, of which chromosomes are made - viruses, also nucleo-proteins, have the same property - but it is not fully understood. The action of genes within the cells, the means by which they give expression to the characteristics associated with them, is mediated by enzymes.

Genes and Meiosis: When a nucleus divides by reduction division to form gametes, the chromosomes first become associated in homologous pairs. (Revise Meiosis, if the process is not fresh in your mind.) Each chromosome of such a pair bears one gene only from each allelomorphic pair. This is the basis for Mendel's First Law: only one gene from each allelomorphic pair is contained in each gamete, because only one chromosome (or pair of chromatids) from each "bivalent" enters each daughter nucleus.

Linkage: The chromosome theory of heredity also explains the exceptions to Mendel's Second Law. All factors do not segregate independently: two genes from different pairs may normally be found in conjunction. This occurs when these two genes are borne on the same chromosome.

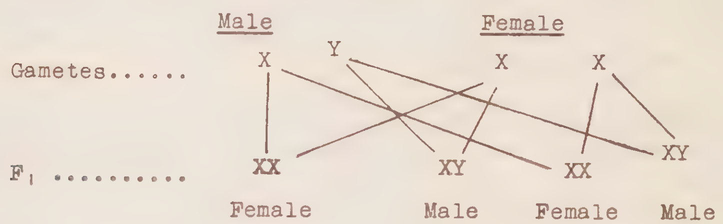
Crossing-Over. Genes normally linked are sometimes separated, however. This is a result of "crossing-over", the exchange of pieces of chromosome within a bivalent, which occurs at the diplotene stage of meiosis. This phenomenon is an important method by which variations are introduced, new combinations of genes being transmitted to the offspring.

Evidence for the Chromosome Theory: The theory outlined above was first suggested because hereditary factors were likely to be borne in the nucleus of cells - the male gamete is often very little more than a nucleus - and because the chromosomes in the nucleus are the only structures which persist throughout nuclear division, and behave as would be expected of gene vehicles. They remain discrete entities, they are associated in pairs and then only one member of each pair passes into each gamete: fusion of gametes recombines the chromosomes. Linkage groups have been discovered by extensive experiments with one species, such as the sweet pea, and the number of linkage groups corresponds with the haploid number of chromosomes. The longitudinal arrangement of genes on chromosomes is suggested by the longitudinal splitting of chromosomes. It is confirmed by careful studies of crossing-over, on large numbers of a single species. The crossing-over is observed cytologically, and the genetic consequences noted. In this way "cross-over" maps have been made, for a few intensively studied species such as Drosophila, and these maps define the situation of particular genes on particular chromosomes.

SEX DETERMINATION AND SEX LINKED FACTORS

The sex of an individual animal is determined primarily by the chromosome-content of every single cell of the organism. This basic sex, already determined in the zygote, is later reinforced by production of the appropriate sex hormones. In abnormal cases, the opposite hormones may preponderate, and the original sex of the animal may be nullified or even reversed.

One of the bivalents formed at meiosis consists of sex chromosomes. In the female (of most animals: in a few exceptions it is the male) these two chromosomes are alike - they are referred to as X. The female then has the constitution XX. The male, however, has an unlike pair of chromosomes, XY (or the second chromosome may be entirely missing, XO). When the male and female gametes fuse, the probability is that an equal number of male and female offspring will be formed:



i.e. 2 female : 2 male.

These sex chromosomes, unlike the other chromosomes, bear very few genes. Such genes as they do bear will clearly be "sex linked": any genes on the Y chromosome will only be found in males.

A fuller account of sex determination and sex linkage is found in Grove & Newell.

GLOSSARY

Instead of being given a glossary of genetic terms which you should understand, you will have in the Test a question on definitions. If you cannot find the answers in your text-books or a biological dictionary, learn them from the Model Answers in the next Lesson. It will cement your understanding much better to try to explain these terms yourself in the first place.

GENETICS AND EVOLUTION

The mechanism by which offspring resemble their parents has been explained: hereditary factors or genes are passed down from parent to child, and these genes determine the characteristics which later develop. This mechanism, as well as ensuring continuity, also provides opportunities for introduction of variations. These randomly occurring variations are the raw material of Evolution, and therefore it is important to understand the different way in which genetic variations arise;

1. By Recombination of Genes: This is the main method. Since there are a very large number of genes in any species, and nearly all are reshuffled at every mating, clearly the possibilities of variation are very great. Crossing-over, with breakage of linkage groups, increases the amount of recombination in each mating.

2. By Gene Mutation: Mutation is the change in nature of a gene. Large-scale mutations are rare, and so drastic as to be nearly always harmful: however, very minor gene changes, inconspicuous when they first occur, are now known to be quite common. The smaller the effect of a mutation, the greater the chance that it will become advantageous in a future generation. Since the discovery that DNA is the essential carrier of genetic information, it has become clear that the specificity of a gene depends on the sequence of nucleotide units within the DNA molecule. Small changes in the replication of DNA down the cell generations constitute gene mutations.

3. Variability of the Effects of Genes: To realise how great an amount of variation is provided by gene recombination and gene mutation, it is extremely important to realise that genes have different effects in different environments. Genes themselves do not change (bar mutation), as is shown by their re-appearance in later generations, but the effect of a given gene varies according to its environment, in particular, according to the other genes present. It is not possible to equate a gene with the characteristics which it normally produces. This was possible in Mendel's original experiments, or the "atomic theory" of Genetics could never have been formulated, but these examples are now known to be exceptional. Many genes combine to affect a single character: a single gene may have multiple effects. Any gene-induced change during development is likely to have wide-spread effects. Recombination of genes is not a simple shuffling of definite effects; each particular genotype may be different from any other. The total "gene complex" rather than the sum of the separate genes must determine the characteristics of the organism.

For further reading on this subject, see Ford, "Mendelism and Evolution". A useful summary of elementary genetics is given by Auerbach, "Notes for Introductory Courses in Genetics", in spite of the outdated evaluation of mutations.

NUCLEIC ACIDS

The Nucleic Acids (DNA and RNA) are very important substances which have briefly been mentioned in the Lesson on Cytology (please refer back to this now) and in the present Genetics Lesson. A fuller introduction to their nature and action is now necessary (knowledge of this exciting recent growing point in Biology is increasingly demanded by modern Syllabuses).

DNA and RNA are complex organic substances consisting of a large number of units called nucleotides. Each nucleotide consists essentially of three main components:

(a) Nitrogenous base (purine or pyramidine)
(b) Sugar (De(s)oxyribose in DNA, d-ribose in RNA. This is the chemical difference between the two compounds)
(c) Phosphate ($-PO_4$).

Since these compounds are acids, they occur in close conjunction with basic proteins. The effects of the nucleic-acid part of the complex can be isolated by specific destruction of DNA or RNA with the enzymes deoxyribonuclease or ribonuclease. This method has replaced the older, less specific, tests (Feulgen staining for DNA, cytoplasmic basophilia for RNA).

The essential property shared by both DNA and RNA is that of self-replication, or reproduction. It is this property which gives DNA and RNA their vital importance.

DNA is the genetic material: it is the sequence of the nitrogenous bases in the nucleic acid molecules which confers the difference between genes. The physical configuration of the molecule is as important to its function as is the chemical content, and must briefly be described here:

DNA is highly polymerised, i.e. each molecule contains very many nucleotide units. The molecules occur on the chromosomes as double chains, joined by cross-connections like the rungs of a ladder. These linked double chains are wound into a tight helical spiral, which in turn is wound round a core of basic protein, to constitute a chromosome.

The two chains of the DNA molecule consist of nucleotides arranged like this:

```
Sugar - Base.................Base - Sugar
  |                                   |
Phosphate                          Phosphate
  |                                   |
Sugar - Base.................Base - Sugar
  |                                   |
Phosphate                          Phosphate
```

Only four different nitrogenous bases are involved in the formation of DNA: the purines Adenine and Guanine, and the pyramidines Thymine and Cytosine. The link between the two chains of the molecule is always either between adenine and thymine, or between guanine and cytosine. Yet from this very simple basis, sufficient variation can be obtained in the sequence and arrangement of nucleotides to make all the different genes which occur.

There is of course a very great number of kinds of DNA: every species, indeed every plant and animal, must differ in DNA content. Within one organism, however, the DNA content of each cell must be the same. (NOTE that these two statements follow from the basic assumptions of genetics, if "DNA" is substituted for "genes".) Mutation is thus seen as some minor rearrangement of nucleotide base pairs, and examples are known where change in a group of very few nucleotides indeed can constitute genetic difference.

DNA has two roles:

(a) Self replication, i.e. manufacture of DNA, revealed when a chromosome divides into two chromatids at mitosis or meiosis.

(b) Manufacture of RNA, which governs the synthesis of enzymes or other proteins within the cytoplasm.

Thus DNA can either divide to make a new set of genes, or it can make RNA for protein synthesis in the cytoplasm (it is understandable now that cells tend either to be capable of division or to be highly differentiated, but not both at once). In fashionable language, DNA (a) conveys information from generation to generation (reproducing genes) and (b) conveys information from nucleus to cytoplasm (making RNA to specify which proteins the cell should make).

RNA has a simpler structure: it is less highly polymerised than DNA and occurs in single chains, folded and complex. Different kinds of RNA have characteristic differences in molecule size: at the present time three main groups of RNA types are recognised:

(a) Ribosomal RNA, with large molecules

(b) Transfer or soluble RNA, with smaller molecules

(c) Messenger RNA, with small molecules.

The RNA made by DNA on the chromosomes is the small molecule kind, "messenger RNA". These RNA molecules in some way pass from the nucleus into the cytoplasm, carrying genetic information to the large molecules of RNA which constitute the ribosomes. The job of ribosomal RNA is to assemble amino acids and to make polypeptide chains for protein synthesis. First, however, the amino acids must be activated by certain enzymes and ATP (see your Lesson on Respiration and must become attached to the third kind of RNA, soluble or transfer RNA, of which there is probably a specific kind for each amino acid. The activated amino acids thus brought to the ribosomes are then made into proteins according to the nuclear instructions. Our picture of this whole process is still very incomplete: the above account is a simplified version of the picture we form in 1967.

Please remember that this study of the role of DNA and RNA is a major growing point in Biology at the present time. The importance of DNA was only established in the nineteen-fifties and the different kinds of RNA began to be identified in the early nineteen-sixties. Any account of nucleic acids will become out-of-date. Use whatever is your most up-to-date source.

Bacteria, although they lack nuclei, contain DNA and RNA acting very much as they act in cells of higher organisms: indeed much of our knowledge about the nucleic acids stems from work on the relatively simple cells of bacteria. Nuclear material is not separated from the cytoplasm by a nuclear membrane, but particles made of DNA and protein are scattered throughout the cell, and provide genetic information in higher organisms.

Recent work reveals a form of sexual process in bacteria. There is no complete fusion of two cells to form a zygote: on the simplest definition, it is still correct to say that bacteria are asexual. However, mutations occur in bacteria, and study of different mutants cultivated together has established that occasional "mating" occurs, with transfer of genetic material in one direction only. Thus genetic recombination can occur, and the genetics and evolution of bacteria are altogether far more similar to those of other organisms than was formerly supposed.

Viruses are examples of nucleoprotein particles with the property of self-replication. Viruses occur only inside living cells, and cause infectious diseases in animals, plants and bacteria,

THE STRUCTURE OF VIRUSES: Viruses are extremely small particles which pass through filters and are invisible under the light microscope. The electron microscope and crystallographic methods have revealed their structure: for example, tomato mosaic virus consists simply of a rod, which is a protein helix wound round a hollow core, with RNA molecules borne on the protein chains near the core. The infectivity of the virus depends on the RNA, i.e. the RNA acts as its "genes", if the concept can be thus extended. Other viruses have different shapes and contain DNA instead: for example, the bacteriophage which infects the bacterium E.coli consists of round bodies with tails: the shell and t il are protein, and the core of the round body is DNA, which carries the genetic information (it cancels the effect of the DNA in the bacterium host by giving its own instructions to the bacterial RNA).

ARE VIRUSES ALIVE? Viruses lack the vital functions except for reproduction. They can only reproduce and exert their effect when inside living cells. Some small viruses have been crystallised and subsequently reintroduced to cells, when they again become active. All these are not the properties of independent living organisms. On the

other hand, some of the larger and more complex viruses appear very much alive. There is no simple answer: viruses blur the distinction between living and non-living things. There is at any rate a great gulf between viruses and the next simplest living things, bacteria, which are altogether far more like plants and animals.

THE ORIGIN OF VIRUSES is also obscure. There is no evidence that they all have a common origin. They may be primitively "free genes" which have become parasitic, or they may be degraded parasites, i.e. derived from parasitic bacteria with extreme simplification of structure. They are at any rate interesting and important examples of nucleo-proteins in isolation.

PRACTICAL WORK

If you have the opportunity (e.g. by visiting a Biological Museum) you should look at the results of experiments in Genetics: specimens are often set out to illustrate the Mendelian ratios.

T E S T 24

1. Explain concisely the following terms:

   (a) gene and allelomorphic pair; (b) dominant and recessive;
   (c) homozygous and heterozygous; (d) genotype and phenotype;
   (e) linkage and crossing-over.

2. Write a brief account of the chromosome theory of heredity.

3. The normal colour of budgerigars is green. Two common mutant forms have occurred, a yellow and a blue. Both these are recessive to the wild green form. The yellow is due to lack of a blue factor, and the blue to lack of a yellow factor. Explain how you would attempt to combine these two mutants into a pure breeding white form. What would be the theoretical expectation if the new white form were crossed with a pure wild form, and the offspring mated together?

SPECIMEN ANSWERS TO TEST 23

1. What is the connection between Evolution and the classification of living organisms?

   Evolution is the origin of new forms of plants and animals, by a series of gradual change down the generations. The connection between Evolution and the classification of living organisms is simply that the classification generally adopted attempts to follow the evolutionary sequence. There are any number of different ways of classifying any objects: by size, colour or any other characteristics. Artificial classification is often used in Biology, for example when compiling a key for identification of flora or fauna: however, the most informative method of classification is that which reflects evolutionary history - a "natural" classification, as it is called.

   Animals and plants were classified into species, genera, families and phyla long before Darwin formulated the theory of Evolution. Organisms closely alike, which interbred and produced offspring basically similar to themselves, were placed in the same species. Organisms slightly less alike, which bred true within their own species but not between different species, were assigned to different species of the same genus - this method of describing and

classifying organisms was established by Linnaeus. Genera were grouped into families, super-families, sub-orders, classes and finally phyla, a phylum being a group of animals or plants with the same basic structure, or "level of organisation", but usually including widely divergent forms: for example, among plants, the Thallophytes form one phylum: the Algae, Bacteria and Fungi, widely different, but alike in not having a differentiated stem, leaf and root. At the other extreme, all the flowering plants constitute another phylum, the Angiosperms. In animals, the lowest phylum is the Protozoa, all unicellular: higher up the scale of organisation are the multicellular forms with two cell-layers, the Coelenterates (Hydroids, Sea Anemones, Jellyfish and Corals), and then the worms with three cell-layers. At the most complex level, the Vertebrates all belong to the same phylum: Fish, Frogs, Reptiles, Birds and Mammals.

When these classifications were drawn up, Biologists still believed (or thought they believed) that every distinct species had been separately created. Intermediate forms which could not easily be assigned to a species were simply dismissed as a nuisance. Darwin's theory of Evolution then suddenly illuminated the picture, and the classification was seen to be "natural": the earliest forms of life were unicellular: cells later aggregated to form two cell-layered animals, and later three cell-layers evolved: the more highly organised phyla had been derived by a series of steps, many of these steps being represented by present-day examples. Present-day worms are not, of course, derived from present-day Coelenterates: nor are the Jellyfish and Anemones known to us derived from Amoeba: but the classification of existing animals, from the most simple to the most complicated, reflects the stages of Evolution.

Classification is often difficult, even when the process of Evolution is recognised. Do two creatures resemble each other because they are close relations, or because they have become adapted to the same environment although they spring from different stock? Are Birds and Bats closely related because they both fly? or are they two different groups which have evolved parallel adaptations (which is the answer)? These questions can only be answered by studying and comparing a large number of forms, when it should become clear what the direction of Evolution has been, and which characteristics indicate close relationship and which are adaptive.

Studied in this way, classification becomes meaningful and interesting. Instead of arbitrary pigeon-holing, taxonomists are tracing the evolutionary history of animals and plants.

2. <u>What classification of Mammals are you familiar with? Point out the characteristics which separate the various orders.</u>

The Mammals are highly adapted in every way to terrestrial life, with a few members having become secondarily adapted to an aquatic life. The main characteristics include the possession of hair as an outer covering, the secretion of milk from mammary glands in the female, and intelligent behaviour. Certain differences, however, make it necessary to divide the class into three sub-classes; the Monotremes, which are closely related to Reptiles, the Marsupials which are primitive in some respects, and the Eutherians, which are the higher Mammals.

<u>The Monotremes</u>, e.g. the Duck-billed Platypus, are not viviparous, but lay large yolky eggs as found in Reptiles. The females do not possess mammary glands, but a milky secretion accumulates in a pocket in the abdomen.

The Marsupials, e.g. the Kangaroo, are viviparous, but the young are born in an immature state. They complete their development within a pouch on the abdomen of the mother, and are fed on milk. This subclass contains two orders: the Didactyla, which includes carnivorous members which are polyprotodont; and the Syndactyla, whose members are mainly herbivorous and diprotodont.

The Third Class, the Eutheria, are more highly developed than the Marsupials. The young are born in a more mature state, and they are fed on milk from the mammary glands. The brain is well-developed, and a higher intelligence is reached. The class comprises many orders, separated largely by diet and habitat, and the modifications associated with them.

THE INSECTIVORA include small animals such as the Hedgehog and Mole, whose diet is insectivorous. Accordingly, the intestine is short, and the caecum likewise.

THE RODENTIA are all herbivorous, with very sharp incisors for gnawing. Associated with the herbivorous habit, the intestine and caecum are large.

THE CARNIVORA include the Dogs, Bears and Seals, all of them being carnivorous, and in consequence they possess large canine and carnassial teeth. The caecum is not well-developed, in association with the absence of vegetable food.

THE ARTIODACTYLA, or the even-toed Ungulates, are large, herbivorous Mammals. They walk on their 3rd and 4th digits, which are of equal size.

THE PERISSODACTYLA comprise the odd-toed Ungulates, which have a 3rd digit which is developed in excess of all others, and is used for walking.

THE CETACEA are the Mammals which have adopted an aquatic form of life. They have bodies which are streamlined and which bear no hair.

THE CHIROPTERA are small Mammals which have become adapted to flight. A web of skin stretched across the elongated digits forms the organ of flight.

THE ORDER LEMUROIDEA includes the Lemurs, which are highly-developed for life in trees and climbing.

The highest order is the ANTHROPOIDEA, which includes Apes, Monkeys and Man. In these types, the brain is highly-developed and the limbs are not fused or specialised for any one particular type of activity. Thus the types can undertake a variety of activities, which helps to account for their dominance.

3. Give the distinguishing characters of any FOUR phyla of Invertebrate animals you have studied. Illustrate these characters by reference to specific examples.

PROTOZOA are microscopic animals whose bodies are not sub-divided into cells: the body is morphologically equivalent to a single cell of a Metazoan, e.g. Amoeba, Monocystis, Plasmodium [draw one of them] although this single cell performs all the vital functions. Even where there is more than one nucleus (e.g. Paramecium), different nuclei do not govern a restricted area of the cytoplasm, but each serves the whole cell (the meganucleus for metabolic functions only,

the micronucleus for over-all control and initiation of reproduction). Various degrees of differentiation occur within the cell. Feeding is normally holozoic (or parasitic) but there is no clear distinction between Protozoa and holophytic unicellular plants, and "Protozoa" such as Euglena may contain chlorophyll.

COELENTERATES are multicellular animals with two cell-layers, the ectoderm and endoderm being separated by a non-cellular mesoglea. They are radially symmetrical. The body wall surrounds the coelenteron, filled with water from the external medium and opening to it by a single opening, the mouth, which is surrounded usually by a ring of tentacles. [Draw Hydra.] The tentacles and other regions bear characteristic stinging cells, the cnidoblasts. There is a nerve network, with no controlling centre. Coelenterates exist in one or other of two forms, the polyp (as in Hydra) and the medusa (e.g. Jellyfish), in which the mesoglea is much expanded to make an umbrella-shaped organism. Usually both forms occur in a single life-cycle, as in Obelia, the polyp being the feeding form and the reproductive medusa bearing gonads and also acting as the dispersal agent. Coelenterates may be solitary (Hydra) or colonial (Obelia) and characteristically have great powers of budding and regeneration. Unspecialised interstitial cells can give rise to other cell types, and are scattered in the body wall, as similar cells are not separated into tissues.

PLATYHELMINTHS are triploblastic Acoelomates, with bilateral symmetry and a distinct head end (except in much modified parasites, such as the Tapeworm). There is a single opening to the gut (lacking in Tapeworms) which branches all over the body. Branching organ systems are characteristic of the group [draw Planaria]. There is no blood vascular system, excretion is by a system of flame cells, and there are complex hermaphrodite reproductive organs. Platyhelminths are usually small and leaf-like in shape (e.g. Planaria and Fasciola). Parasitic characters have developed strongly in this phylum, in the Trematodes such as Fasciola and the even more highly adapted parasitic Cestodes, such as the Tapeworm.

ANNELIDS are triploblastic Coelomates with metameric segmentation. There is a moist body wall covered by a glandular epidermis and including longitudinal and circular muscles. The body is usually long and thin in marine Polychaetes (e.g. Nereis) and freshwater or terrestrial Oligochaetes (e.g. the burrowing Lumbricus), but is shortened in the Hirudinea (leeches). The alimentary canal opens at either end (mouth and anus), the coelom is perivisceral, there is a blood system and excretion is by nephridia, which may be combined with coelomoducts. Characteristically, each segment bears one pair of each of the internal organs, and externally bears parapodia (marine forms such as Nereis) or only chaetae in burrowing forms such as Lumbricus. There is a ventral nerve cord with a ganglion in each segment, and an anterior cerebral ganglion. Nerve cells are distributed along the length of the cord, not confined to the ganglia. There is a free-swimming trochophore larva in most marine forms, but freshwater and terrestrial worms usually have direct development within an egg. The head end is well defined, and in forms such as Nereis bears eyes and other sense organs and external jaws: these are secondarily lost in Lumbricus.

JANET MOORE, M.A., Ph.D.(Cantab.)

ZOOLOGY/A WOLSEY HALL, OXFORD LESSON 25

SET WORK

JECT: ECOLOGY: The Interdependence of Plants and Animals, The Distribution of Plants and Animals, Animal Communities, Modifications by Man, The Nature Conservancy.

READING: Grove & Newell, Ch. XXII.

NOTES

ECOLOGY

Ecology is the study of animals and plants in relation to their environment ("eco" is derived from a Greek word meaning "house" as in "economics"). The environment is determined partly by physical factors such as climate, temperature and topography, and partly by biological factors, i.e. all the other animals and plants occurring in the same place or "habitat". Thus Ecology is not only the study of physical factors determining the distribution of animals and plants but also the study of how animals and plants interact with each other in nature to form communities.

Ecology is ~~essentially~~ a practical subject ~~which must be studied~~ in the field. It is scientific natural history, combining the approach of the old naturalists, who observed and described different sorts of living creatures, with more modern methods of experimental research. is Lesson can only briefly introduce you to this vital subject: cal because Man himself is a living organism affected by other living organisms and having an enormous effect on the plant and animal communities around him. In this Lesson, first the interdependence of plants and animals will be discussed, then the factors determining the distribution of animals and plants will be indicated. The application of ecological findings to Pest Control will be considered in the next Lesson, about the relationship between animals and Man.

THE INTERDEPENDENCE OF ANIMALS AND PLANTS

"Why all this talk about plants?" you may ask: "We are Zoologists". The answer is that all animals are ultimately dependent upon plants for their food: only plants possess chlorophyll, only plants are able to manufacture the organic compounds which animals need as food. Therefore no animals can exist in any place unless there are plants there too, and fluctuations in plant populations may well determine the populations of animals.

Food Chains: If animals do not feed directly on plants, they feed on other animals which in turn feed on plants. In this way food chains are set up (A eats B, B eats C, etc.). The last member in the food chain will always be a green plant. For example, we eat beef, the cow eats grass. Or in the sea, big fish eat smaller fish, smaller fish eat crustaceans in the plankton, and these crustacea depend on the green diatoms which are the ultimate source of food for most marine ganisms.

Decomposition of dead bodies, and of the excreta of living animals, is an important process by which animals in their turn provide food for plants. In the soil there are bacteria which break down decaying and excreted nitrogenous compounds into nitrates, and these nitrates can be used by plants to make new proteins. In this way a circulation of nitrogen is maintained.

Gaseous Exchange is another example of the interdependence of plants and animals. Green plants in sunlight take in carbon dioxide, for photosynthesis, and give off oxygen. Animals on the other hand take in oxygen for respiration, and give off carbon dioxide (plants also respire, but by day photosynthesis exceeds respiration in net effect). Again, when plant and animal bodies die and are decomposed by bacteria, carbon dioxide is released. In this way, by the sum total of the activities of plants and animals, the proportion of carbon dioxide in the atmosphere remains roughly constant.

Other Examples of the Interdependence of Plants and Animals are important: for example, many animals are sheltered or concealed by plants; many plants are pollinated or dispersed by animals, and many other special examples exist.

THE DISTRIBUTION OF PLANTS AND ANIMALS

As has been explained, the distribution of plants and animals depends both upon the physical surroundings and upon the biological environment, i.e. all the other plants and animals which are present.

1. The Physical Environment is determined by CLIMATIC FACTORS (determining the supply of light, oxygen, water, and the temperature) and TOPOGRAPHICAL FACTORS. (Mountains and valleys, exposed places and sheltered corners, all have their characteristic flora and fauna. Different rock strata determine the type of soil, which is very important in determining the distribution of land plants.)

   Physical factors important in limiting the distribution of living things include:

   LIGHT, which is essential for green plants to feed, and therefore essential for the end-point in every animal food chain.

   TEMPERATURE: few organisms can live in extremes of temperature. Mammals and Birds have evolved the power of temperature-regulation and thus are relatively independent of environmental temperature. Special adaptations are found in inhabitants of the polar regions, e.g. the insulating blubber of Whales.

   OXYGEN is essential to all aerobes, and must be freely available: few organisms can live in very deep water or on high mountains where the oxygen pressure is very low.

   WATER is an essential food. Certain land plants (xerophytes) have special adaptations to lack of water, as also may animals: for example, the Camel is able to store water and therefore survive in the desert.

   SALINITY (salt concentration) of water is an important factor for aquatic organisms, which are adapted either for life in very salty water (the sea) or for life in fresh water containing little salt (ponds and streams). Fresh-water animals require a kidney or other organ capable of performing osmotic work, to pump out the excess water which enters by osmosis over the respiratory surface.

2. The Biological Environment: The linking of animals and plants by food chains has already been mentioned. The numbers of any one species depend partly on the numbers of their predators (animals which eat them) and on the numbers of food species available. The particular group of plants and animals living together in one place reaches an equilibrium (often called "the balance of nature") and a change in the population of any one species will have far-reaching effects throughout the community. The pressure of numbers of

organisms is such that competition is intense: any unsuccessful individuals or species will die out, and those that survive will reach a new equilibrium with other organisms present. Thus the "balance of nature" is very easily altered by changing conditions or introduction of new species. It is quite incorrect to talk about "the balance of nature" as something fixed once for all, and upset only by Man's interference.

At the same time, it is very important to realise what an enormous effect that particular animal, Man, has had upon populations of other animals and plants. In England today, there is no "natural" country left. Nearly all the woods which we know today were planted at some period by our ancestors: the chalk downland was produced by Man cutting down earlier forests, and the heath is nearly always secondary too. Agriculture down the ages and "development" interferences of many kinds have set up new communities throughout the country, in addition to the more obvious effects of Man introducing new species and causing others to become extinct.

In recent years, the virus disease myxomatosis has greatly reduced the rabbit population of England, and this illustrates the above remarks about the far-reaching effects of increase or decrease in any species. Farm crops, of course, are benefiting. Woods are regenerating as never before (in recent centuries) as there are few rabbits to eat the young trees. Chalk downlands will rapidly become scrub and then woodland, unless we take the chance to put sheep on them, to eat the grass formerly kept down by rabbits. What will the effects be on other animals? Hares, natural competitors of rabbits, may increase. Will voles increase, with more vegetable food available? or will they decrease because rabbit predators (foxes, birds of prey, etc.) will now largely live upon voles? or will these predators become very scarce through lack of rabbits? A survey of the buzzard population before and after myxomatosis is yielding interesting results — now obscured because myxomatosis is becoming endemic and many rabbits are now immune. In general, we do not know what new balance will be reached, and we cannot predict. Unlike more exact sciences such as Physics and Chemistry, in Ecology precise predictions are not possible, because the inter-relations of causes and effects are so complicated.

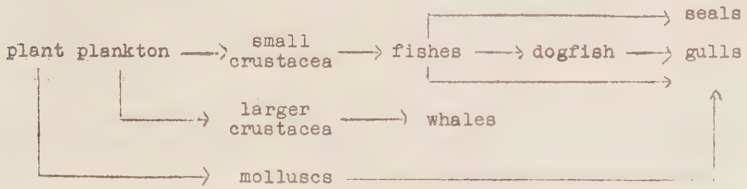
ANIMAL COMMUNITIES

1. Dependence on Plants Present: It has already been mentioned in the introduction how in any community the basic food is provided by the plants, and these will determine the majority of the herbivorous animals. In some communities the source of plant food may not be immediately obvious: on the seashore surprisingly few of the animals except certain molluscs live on seaweed. Most of the food is planktonic, i.e. microscopic plants and animals floating in the water, which is brought to them with the incoming tide, and thus the basic food is the plant plankton floating in the open sea. In addition to food, large plants - and trees in particular - create a particular environment which attracts many animals because of the shelter. Most of the large British Mammals, Foxes, Badgers and Roe and Fallow Deer, characteristically live in woods for this reason.

   Plants may also provide nesting sites, and a hedgerow, for example, will have a far higher number of birds' nests than a correponding strip in a nearby field.

2. Dependence on Other Animals: FOOD is again the most important link between the animals in a community, and the most intricate relationships exist between the animals and their food. Most animals except the very largest have a wide range of predators, while most carnivores eat many different types of prey. To take but one example,

most of our British carnivorous animals and birds (Foxes, Weasels, Kestrels, Buzzards, etc.) eat Field Mice, but any one of them will probably prey on anything from Grasshoppers to Rabbits, as they are available, as well as Field Mice. These relationships are known as food chains: each animal feeding on the one below and being itself eaten by the one above in the chain. The following food chain is a simplification of what occurs in the North Atlantic.



Food chains invariably progress from smaller, more numerous species to larger animals that are less abundant, as the smaller ones obviously cannot provide food for an equal number of larger predators. So any community will possess many small herbivores and increasingly few animals of larger size. This is known as the PYRAMID OF NUMBERS. Any field, for example, may support many Mice and a fair number of Rabbits, a pair or two of carnivorous Stoats or Weasels, and perhaps form only part of the territory of a Fox.

ECOLOGICAL NICHES: As a result of this complex web of food relationship each species occupies its own position in the community, the position being known as its ecological niche: it may overlap with that of similar animals sharing the same food, but in any community the niches are usually specific to a particular species. This is the result of centuries of slow adaptation during the evolution of the different animals, so each is only found where it is best fitted to survive. But similar niches are found in a wide variety of communities: that of small, rapidly multiplying herbivores is filled by the Rabbit in this country, and by a rodent called the Agouti in South America; perhaps it is not even too far-fetched to say that fish like the Herring occupy a similar position in the sea.

COMPETITION: Despite the way a community is adjusted, with each animal in its own niche, competition is inevitable where requirements overlap. It may be between members of the same or different species; for example, Rabbits will compete with each other for the grass of a field and also with the Cows that are grazing there. Competition occurs not only over food but over nesting sites and so forth, or simply over space. If you clear a rock on the sea-shore of its colonies of mussels, barnacles, limpets and seaweeds, you will find within a few months that the space is again covered as densely as before, showing what intense competition there is between many animals and seaweeds for this valuable surface in the intertidal zone.

3. <u>Populations</u>: The study of an animal community is incomplete without some knowledge of the numbers of animals and how they vary. Abundant animals have a greater effect on the community's economic life than rarer ones of similar size and eating habits, while variations in t size of a population of a species at any point in a food chain will have repercussions throughout the community. Gamekeepers used to shoot all birds of prey in order to encourage game-birds such as Pheasants and Partridges, but in so doing they removed a natural check on the numbers of small hedgerow birds, such as Sparrows and Buntings, which are agricultural pests.

So many factors affect the numbers of a species that to understand what underlies the size of populations involves knowing almost everything about a particular species.

The numbers are increased by both breeding and immigration, and may vary either with the food or the climate; the clutch size of ome birds has been shown to vary with the available food, while climatic conditions such as a hard winter may drive many birds from upland areas to escape both food shortage and extreme cold. If the population is steady, factors tending to increase the numbers will be balanced by emigration and death, and again either of these may be affected by innumerable environmental circumstances. Death, for example, may be caused by disease or parasites, or by the animal being eaten, or by a climatic catastrophe such as extreme cold or drought, or by food shortage. Often a combination of factors will be responsible; an animal weakened by parasites or starvation is more likely to be eaten. Death from old age is extremely rare, as old animals are less vigorous and therefore more likely to fall victim to predator or disease.

4. Dispersal: The ability of animals to spread from one geographical area to another has great evolutionary consequences, as both on the edge of their normal range and in the new areas which they can colonise they are likely to encounter slightly different environmental conditions. Thus the species may adapt to the new conditions and so break up into slightly different geographical races; if these are isolated from each other, they may evolve into distinct species.

MODIFICATIONS BY MAN

Most land habitats in Britain are man-made. Perhaps the outstanding bi ic factor in land ecology is that Man is a terrestrial animal! This fact has already been indicated, but needs to be emphasised further.

WOODLAND: Originally, most of this country was forest, but hardly any of our present day woods are natural. Man cleared the forest by cutting and burning, and his grazing animals have prevented tree regeneration, or the bare earth has eroded until there is not enough soil to bear trees. Nearly all our woods have been greatly modified by man, and many are entirely man-made plantations.

DOWNLAND was originally all covered in forest, and it would revert to scrub or forest if we let it. Southern downland is usually chalk grassland, kept short by rabbits and/or sheep, but there are all gradations from fairly natural grassland to grass sown in fields.

HEATH and MOORLAND was also originally forest, which is now constantly kept open by grazing and burning. Heather is often the dominant plant, since it thrives on regular burning, with gorse and bracken also. Heath land in the South of England is rapidly vanishing: Man is taking it either for building, or for forestry, or for quarrying gravel and ball clay, or reclaiming it for farms, as can be done with present-day chemicals. There will soon be no heathland left in Dorset outside the special Nature Reserves for it.

Much more could be said about the far-reaching effect of Man on pl t and animal communities which appear to be entirely "natural". As you go about England, remember that nearly all the natural scenery which you are enjoying is a product of man's activities in the past, even if it now appears to be entirely "wild country".

THE NATURE CONSERVANCY

We are belatedly realising, in this overcrowded island of Britain, that if we wish to preserve our most varied scenery and plant and animal life, we must actively plan to do so, before housing programmes and industrial developments use up so much of the land that the areas left become too small to support plant and animal populations. For this reason a body called the Nature Conservancy was formed in 1949, and has set up many Nature Reserves and embarked on many programmes of ecological research. You may still be able to obtain the Conservancy's pamphlet, "The First Ten Years", and you are recommended to read the article on "Nature Conservation in Britain" by T.B. Cragg, in "New Biology" No. 26.

It is not enough to buy or rent a piece of wild country as a Nature Reserve: merely to put a fence round it may change its character entirely. Much skilled knowledge is necessary for successful management of reserves, and the Conservancy has initiated much research into the conditions in which various plant and animal communities will thrive. The Reserves are intended to be "outdoor laboratories" as much as "living museums".

We have progressed a long way from the last century, when the only deliberate ecological control by Man was game-bird preservation. We now realise that the problem of biological control (which includes preservation of rare species) is an exceedingly intricate one. Further, the problem is not confined to small over-crowded islands like our own: all wild game in Africa appears to be doomed unless conservation methods are quickly applied. Influential people in this country are now getting moving, exactly fifteen years after the problem was first pointed out as urgent. Our own Nature Conservancy has the relatively tiny annual grant of a quarter of a million pounds, to cover all the price and management of reserves, and all the research and organisation, so that much has t be left undone.

T E S T 25

1. What is meant by the term ecology? Why are ecological studies important?

2. Almost all plant communities are affected by the activities of animals, including Man. Discuss this by reference to one or more natural examples, and suggest what would happen if the animals concerned ceased to have any effect.

3. Describe the more important adaptations of any FIVE organisms you have found living together in any ONE natural habitat.

SPECIMEN ANSWERS TO TEST 24

1. Explain concisely the following terms: (a) gene and allelomorphic pair; (b) dominant and recessive; (c) homozygous and heterozygous; (d) genotype and phenotype; (e) linkage and crossing-over.

   (a) A gene is a hereditary factor, borne on the chromosomes in the cell nucleus. The gene is passed down unchanged (except in rar "mutations") from one generation to another. The presence of a certain gene determines the development of certain characteristics in the individual containing it. Since genes reproduce themselves unchanged in every cell-division, all cells of an organism have the same gene-content.

An allelomorphic pair is a pair of genes which govern a pair of contrasted characteristics. The two genes constituting an allelomorphic pair occupy identical loci on homologous chromosomes. Therefore only one member of each pair enters a gamete at meiosis.

(b) Dominant is applied to the member of an allelomorphic pair whose effect masks the effect of the other member of the pair, when both are present. The other gene of the pair, which is present in the hybrid without having any effect on its characteristics, is termed Recessive.

(c) Homozygous and Heterozygous distinguish between individuals which show a characteristic because they contain only the genes determining that characteristic (homozygous) and individuals which show a characteristic because a dominant allelomorph is masking the effect of a recessive allelomorph (heterozygous). Homozygous individuals will produce gametes of only one kind, as far as this particular characteristic is concerned. Heterozygous individuals will produce gametes carrying either the dominant or the recessive gene: it is this fact, the results of further mating, that reveals a heterozygote as such.

(d) Genotype refers to the genetic constitution of an individual, while phenotype describes the characteristics which appear. A heterozygote showing complete dominance will appear identical to the parent homozygous for the dominant gene: the phenotype is the same. However, the genotype, the genetic constitution, of these two individuals is different. Two apparently similar phenotypes will not breed alike unless they also share the same genotype.

(e) Linkage and Crossing-Over: ~~Linkage is the exception~~ to Mendel's Law of Independent Assortment; it occurs when two genes from different allelomorphs normally segregate together. This occurs when the two genes are borne on the same chromosome. Linked genes, however, may become separated by crossing-over: this is the interchange of portions of chromosomes within a bivalent, when chiasmata are formed at the diplotene stage in meiosis. Portions of chromosomes, with the genes they bear, are transferred to the homologous chromosomes, so that genes previously neighbours on a chromosome now segregate into different gametes. The frequency of separation of any two linked genes depends upon their closeness to each other on the chromosome: if they are very close, the likelihood of a chiasma forming between them is less. Using this fact and studying very many examples, maps of gene loci have been made for a few species.

2. Write a brief account of the chromosome theory of heredity.

The chromosome theory of heredity states that the heredity factors transmitted from parent to offspring are borne on the chromosomes contained in the nucleus of every cell of an organism.

Mendel, a practical plant breeder, had formulated laws about the behaviour of hereditary factors: first that different characteristics are governed by unit factors which persist unchanged down the generations, and that these factors exist in contrasted pairs and only one member of each pair is found in any gamete. Translating this theory into cytological terms, it was evident that the hereditary factors must be contained in the cell nucleus. Every living thing is derived from a cell or cells of other living things, and where there is anisogamy the male gamete very often consists of nothing but nucleus, with a tiny speck of cytoplasm.

The discovery of chromosomes supported and simplified Mendel's hypothesis. Here were bodies in the cell nucleus which persist throughout the nuclear cycle. When a cell divides by mitosis, the chromosomes split exactly into two identical halves, so that the daughter cells will contain the same hereditary factors as the parent. In meiosis, chromosomes come together in homologous pairs, and then separate, only one number of each pair entering each gamete. All this accords exactly with what a vehicle for Mendel's hereditary factors should do.

The hereditary factors or genes are assumed to be arranged longitudinally on the chromosomes. They have the power of self-reproduction when a chromosome divides, and they exert their effects within the cell by means of enzymes. The exact nature of a gene is not understood.

If the behaviour of chromosomes at meiosis is followed, the Mendelian ratios are followed. At meiosis four nuclei are produced, two having each of the allelomorphs in any one pair, i.e. each of the members of a bivalent. When these nuclei are paired, 25% will have the dominant character, 25% the recessive character and 50% will have both dominant and recessive characters, which is exactly what the Mendelian hypothesis stated.

Further support for the chromosome theory is provided by linkage of genes. If a large number of individuals of any species are repeatedly mated, a certain number of groups of linked genes can be traced. This number is the same as the haploid number of chromosomes, suggesting that linkage occurs when genes are borne on the same chromosome. Crossing-over, the breaking of linkage groups, is further explained by the chiasma formation between the members of a bivalent in the diplotene stage of meiosis.

The chromosome theory of heredity also explains sex determination. One of the homologous pairs of chromosomes, called XX and XY, determines the sex of the organism. A male has the unlike pair, XY, while a female has identical sex chromosomes, XX (the position is reversed in some species). When male and female cells fuse, there is an equal chance of male and female offspring. Further, any genes borne on the Y chromosomes can occur only in males: this explains the occurrence of sex-linked characters. The discovery of these special sex chromosomes, visibly different from each other and from all other chromosomes, is yet further evidence that chromosomes are concerned with inheritance.

3. The normal colour of budgerigars is green. Two common mutant forms have occurred, a yellow and a blue. Both these are recessive to the wild green form. The yellow is due to lack of a blue factor, and the blue to lack of a yellow factor. Explain how you would attempt to combine these two mutants into a pure breeding white form. What would be the theoretical expectation if the new white form were crossed with a pure wild form, and the offspring mated together?

===========

If the blue and yellow forms are recessive to the green one, and yellowness and blueness are due respectively to an absence of blue and yellow factors, the genetical composition of the green form must be BBYY where B = blue and Y = yellow; and the constitution of the yellow and the blue would be YYbb and BByy respectively. Only when the dominant factors for blueness and yellowness come together is the individual green, and each character is governed by two genes.

In order to obtain a pure-breeding white form, a type must be obtained in which the two recessive characters occur together: i.e. with the composition bbyy. Thus there is an absence of blueness and yellowness, hence giving a white form.

Crossing the yellow and blue forms:

```
      Blue                      Yellow

      BByy                       YYbb
 By          By              Yb       Yb ..............Gametes

              BbYy          (Green) .................F1
       BY  By      bY   by .......................Gametes
```

These are the gametes normally obtained from the F_1 in a dihybrid cross. Thus in the F_2, individuals would be produced in the ratio 9 Green : 3 Blue : 3 Yellow : 1 White. The last is a homozygous recessive and would thus breed pure for lack of colour.

Crossing the pure white form with a pure wild form:

```
      White                     Green (homozygous)

      bbyy                       BBYY
 by          by              BY       BY ...................Gametes

            BbYy          (Green - heterozygous) ........F1
      BY    By    bY   by ............................Gametes
```

Thus again we would have the F_2 of a dihybrid cross produced by inbreeding the F_1 generation - giving a theoretical expectation of 9 Green : 3 Blue : 3 Yellow : 1 White.

JANET MOORE, M.A., Ph.D. (Cantab.)

APPLIED MATHS. WOLSEY HALL, OXFORD LESSON 19

SET WORK

SUBJECT: Elastic Strings. Principle of Energy. Units & Dimensions.

READING: Humphrey & Topping; Chapter 4, §§4.7 to end.

EXAMPLES: p.145, nos. 14, 18, 20;
p.156, nos. 2, 4, 8, 10, 11, 14, 18;
p.163, nos. 2, 4, 6, 8, 10, 12, 14.

NOTES

Hooke's Law states that the tension of an elastic string varies as the extension of the string beyond its natural length. Thus, if l is the natural length and l_1 the extended length, then the tension T is given by the equation

$$T = \lambda . \frac{l_1 - l}{l}$$ where λ is called the coefficient of elasticity.

The work done in stretching an elastic string is the product of the mean of the initial and final tensions and the extension. This is proved in detail in §4.20.

Energy: The energy of a body is its capacity for doing work, and it is measured in the same units as work. In this subject we have Kinetic Energy due to MOTION and Potential Energy due to POSITION.

KINETIC ENERGY: If a body has a velocity u and a retardation f, which reduces its velocity to zero in a distance x, then $u^2 = 2fx$. Let the mass of the body be m, then multiplying the above equation by m we have $mu^2 = 2mfx$.

But $mf = P$, the force that produces the retardation f in the mass m.

$$\therefore \quad \tfrac{1}{2}mu^2 = Px.$$

But, further, Px is the work done by the force P moving its point of application through a distance x.

$\therefore$ Work done by the mass m due to its velocity u, i.e. the Kinetic Energy of mass m $= \tfrac{1}{2}mu^2$, and is measured in foot-poundals.

POTENTIAL ENERGY is the work a body can do in moving from from its actual position to a standard position. The potential energy at height h is the work the particle can do in falling to the ground and is mgh.

It can easily be shown that the sum of the Kinetic and Potential energies in a system is constant, for, if h be the height of the body when the velocity is v, and x the height of the body when the velocity is u, then

$$u^2 - v^2 = 2g(h - x)$$

$$\therefore \quad \tfrac{1}{2}mu^2 - \tfrac{1}{2}mv^2 = mgh - mgx$$

i.e. difference of kinetic energies = difference of potential energies.

EXAMPLE 1: Find the work done in stretching an elastic string, modulus of elasticity λ, (i) from its natural length c to a length $c + x$; (ii) from a length $c + x$ to a length $c + y$. Show that in all cases the work done is (mean tension) $\times$ (extension).

(i) Extension of string $= c + x - c = x$

$$\therefore \quad \text{Tension} = \lambda \frac{x}{c}$$

When the length is $c + z$, then tension $= \lambda\frac{z}{c}$

then work done in stretching a further distance $\Delta z = \lambda\frac{z}{c}\,\Delta z$.

$\therefore$ from c to $c + x$, the work done $= \int_0^x \lambda\frac{z}{c}\,.\,dz = \frac{\lambda}{2c}\Big[z^2\Big]_0^x$

$$= \frac{\lambda}{2c}x^2 = \tfrac{1}{2}\,.\,\frac{\lambda x}{c}\,.\,x$$

$= \frac{1}{2}$ Tension at end $\times$ extension

$=$ mean tension $\times$ extension.

(ii) Similarly, from $c + x$ to $c + y$, the work done

$$= \int_x^y \lambda\frac{z}{c}\,.\,dz = \frac{\lambda}{2c}\Big[z^2\Big]_x^y$$

$$= \frac{\lambda}{2c}(y^2 - x^2) = \frac{\lambda}{2c}(y + x)(y - x)$$

$$= \left(\frac{\lambda y}{2c} + \frac{\lambda x}{2c}\right)(y - x)$$

$$= \tfrac{1}{2}(T_1 + T_2)(y - x)$$

$=$ Mean Tension $\times$ Extension.

EXAMPLE 2: A spring requires a force of 15 lb. to stretch it 1 inch. Find what work must be done to increase the extension from 1 inch to 2 inches.

Let ℓ inch be the length of the spring and λ its modulus of elasticity, then since the stretch is 1 inch,

$$\therefore \quad 15 = \frac{\lambda}{\ell} \quad \text{or} \quad \lambda = 15\ell$$

and work done in stretching spring 1 inch

$$= \tfrac{1}{2} \times 15 \times \frac{1}{12} = \frac{5}{8}\text{ ft.lbs.}$$

When spring is stretched 2 inches the tension $= \frac{\lambda}{\ell} \times 2 = 30$ lbs., and work done in stretching spring 2 inches

$$= \tfrac{1}{2} \times 30 \times \frac{2}{12} = 2\tfrac{1}{2}\text{ ft.lbs.}$$

$\therefore$ Work done in stretching from 1 inch to 2 inches $= 2\frac{1}{2} - \frac{5}{8}$

$$= 1\tfrac{7}{8}\text{ ft.lbs.}$$

EXAMPLE 3: A force equal to the weight of 5 lbs. acts on a mass of 30 lbs., originally at rest, for 10 seconds. Find, in feet, the distance travelled by the mass, and in ft.lbs., the kinetic energy generated in it.

Let f ft./sec^2. be the acceleration generated in the 30 lb. mass.

$$\therefore \quad 5g = 30f \quad \therefore\ f = \frac{g}{6}\text{ ft./sec}^2.$$

$\therefore$ Distance travelled in 10 seconds $= \frac{1}{2}f \times (10)^2 = \frac{\cancel{32}^{8}}{{}_{3}\cancel{12}}(100)$

$= 266\frac{2}{3}$ ft.

The velocity of the mass at the end of 10 seconds $= \frac{320}{6}$ ft./sec.

$\therefore$ Kinetic Energy in ft.lbs. $= \frac{1}{2}\cdot\frac{m}{g} \times \left(\frac{320}{6}\right)^2$

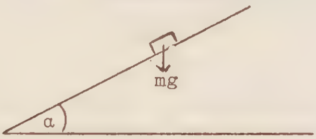
$$= \frac{1}{\cancel{2}}\cdot\frac{\overset{5}{\cancel{30}}}{\cancel{32}}\cdot\frac{\overset{10}{\cancel{320}} \times \overset{80}{\cancel{320}}}{\cancel{36}_{3}} = \frac{4000}{3}$$

$= 1333\frac{1}{3}$ ft.lbs.

We note that work done by force $= 5 \times 266\frac{2}{3}$ ft.lbs.

$= 1333\frac{1}{3}$ ft.lbs. $=$ gain in K.E.

EXAMPLE 4: A particle is projected with velocity V directly up a rough plane of inclination α. Show that when it again has velocity V it will be a distance $\frac{V^2}{g}\cdot\frac{\cos\alpha\sin 2\lambda}{\cos 2\lambda - \cos 2\alpha}$ from the point of projection, λ being the angle of friction which is less than α.



The normal reaction on the plane $= mg\cos\alpha$, and force of friction $= \tan\lambda . mg\cos\alpha$ and always acts to oppose the motion.

The gravitational component $= mg\sin\alpha$, always acting down the plane.

When mass moves up the plane the force opposing the motion $= mg(\sin\alpha + \tan\lambda\cos\alpha)$ down the plane, producing a retardation $g(\sin\alpha + \tan\lambda\cos\alpha)$. When the particle reaches its highest point the force is changed to $mg(\sin\alpha - \tan\lambda\cos\alpha)$ down the plane and this produces an acceleration $g(\sin\alpha - \tan\lambda\cos\alpha)$ down the plane.

Let h be the distance from point of projection to the highest point

$$\therefore \quad h = \frac{V^2}{2g(\sin\alpha + \tan\lambda\cos\alpha)}$$

Again, if h_1 be the distance from the highest point to the point where the velocity is again V

$$h_1 = \frac{V^2}{2g(\sin\alpha - \tan\lambda\cos\alpha)}$$

$\therefore$ $h_1 - h$ is the distance required

$$= \frac{V^2}{2g}\left[\frac{1}{\sin\alpha - \tan\lambda\cos\alpha} - \frac{1}{\sin\alpha + \tan\lambda\cos\alpha}\right]$$

$$= \frac{V^2}{2g}\cdot\frac{2\tan\lambda\cos\alpha}{\sin^2\alpha - \tan^2\lambda\cos^2\alpha}$$

$$= \frac{V^2}{g}\cdot\frac{\sin\lambda\cos\lambda\cos\alpha}{\cos^2\lambda\sin^2\alpha - \sin^2\lambda\cos^2\alpha}$$

$$= \frac{V^2}{2g} \cdot \frac{\sin 2\lambda \cos \alpha}{\cos^2\lambda \sin^2\alpha - (1 - \cos^2\lambda)\cos^2\alpha}$$

$$= \frac{V^2}{2g} \cdot \frac{\sin 2\lambda \cos \alpha}{\cos^2\lambda - \cos^2\alpha} = \frac{V^2}{g} \cdot \frac{\sin 2\lambda \cos \alpha}{(2\cos^2\lambda - 1) - (2\cos^2\alpha - 1)}$$

$$= \frac{V^2}{g} \cdot \frac{\sin 2\lambda \cos \alpha}{\cos 2\lambda - \cos 2\alpha}$$

Students who are taking engineering subjects should read carefully §§4.15–4.17 and the worked-out examples in §4.18; but arts and science students can move on to §4.22 on Units and Dimensions.

The fundamental units are mass, length and time and all other units may be expressed in terms of the fundamental units. Calling the units of mass, length and time by the letters M, L and T then, since acceleration is expressed in ft./sec^2. or cm./sec^2., the dimension of acceleration is $\frac{L}{T^2}$.

Again, force is the product of mass and acceleration, and hence the dimension of force is $\frac{ML}{T^2}$. You should find the principle of dimensions most useful in your work, since any equation arrived at in any problem must have every term of the same dimensions, and any failure calls for a check of the work.

EXAMPLE 5: State the dimensions of force, power, angular velocity, pressure at a point in a fluid.

Force is mass × acceleration $= \frac{ML}{T^2}$

Power is work done in unit time

is force × distance in unit time

is $\frac{ML}{T^2} \times L \times \frac{1}{T} = \frac{ML^2}{T^3}$

Angular velocity is an angle described in unit time $= \frac{1}{T}$, since an angle has no dimensions.

Pressure at a point in a fluid is force on an area

is $\frac{ML}{T^2}$ on $L^2 = \frac{M}{LT^2}$

EXAMPLE 6: Determine, by counting dimensions, whether any of the following equations are impossible or not:

(1) $10Fvst + 8mv^2s - 3mg^3t^4 = 0$
(2) $v^3t - 4mfs + 3F = 0$
(3) $6m^2v + 2g^3Fs^2t^8 - 3F^2st^4 = 0$

Considering the dimensions only, the terms are:

(1) $\frac{ML}{T^2} \times \frac{L}{T} \times L \times T = \frac{ML^3}{T^2}$

$M \times \left(\frac{L}{T}\right)^2 \times L = \frac{ML^3}{T^2}$

$M \times \left(\frac{L}{T^2}\right)^3 \times T^4 = \frac{ML^3}{T^2}$ ∴ equation is possible.

(2) $\left(\frac{L}{T}\right)^3 \times T = \frac{L^3}{T^2}$

$M \times \frac{L}{T^2} \times L = \frac{ML^2}{T^2}$

$\frac{ML}{T^2} = \frac{ML}{T^2}$ $\therefore$ equation impossible.

(3) $M^2 \times \frac{L}{T} = \frac{M^2L}{T}$

$\left(\frac{L}{T^2}\right)^3 \times \frac{ML}{T^2} \times L^2 \times T^8 = ML^6$

$\left(\frac{ML}{T^2}\right)^2 \times L \times T^4 = M^2L^3$ $\therefore$ equation impossible.

TEST 19

1. A spider hangs suspended by a light elastic thread from the ceiling, the modulus of elasticity of the thread being equal to half the weight of the spider. Prove that in climbing to the ceiling the work done by the spider is one-third less than it would be if the thread were inelastic.

2. A light elastic string of natural length a hangs vertically with its upper end fixed and a weight attached to its lower end. Its length is then ℓ. If the weight be depressed through a further distance h and then released, show that it will just rise to the level of the top of the string if $h^2 = \ell^2 - a^2$.

. A pulley $1\frac{1}{2}$ feet in diameter receives 10 H.P. when revolving 180 times per minute, and the tension of the belt on the tight side is $2\frac{1}{2}$ times that on the slack side. Find the tension on the tight side and the width of the belt required if its thickness is $\frac{1}{2}$ inch and the greatest tension it can support is 330 lbs. per square inch of cross-section.

4. A dock 600 feet long and 120 feet wide, with a depth of 36 feet, has to be pumped dry in 6 hours, all the water being lifted to a level of 2 feet above the original water level in the dock. If the useful horse-power exerted by the pumping engines is constant, calculate what it must amount to and show that it takes $1\frac{3}{4}$ hours to empty the last 6 feet of water in the dock. [1 cu.ft. of water weighs 62·5 lb.]

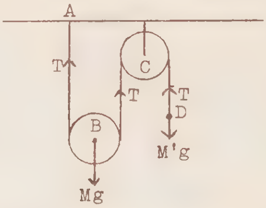
5. An engine of weight W tons can exert a maximum tractive effort of P tons weight and develop at most H horse-power. The resistances to motion are constant and equal to R tons weight. Show that, starting from rest, the engine will first develop its full horse-power when its velocity is $\frac{55H}{224P}$ ft./sec. after at least $\frac{55WH}{224Pg(P-R)}$ seconds. What is the greatest velocity which the engine can attain?

6. A car weighing 1 ton has climbed a height of 100 feet in going 1 mile; it started from rest and is proceeding at 40 m.p.h. at the end. The frictional resistance of the road is 50 lb.wt. What is the ratio of the gains of kinetic and potential energy, what fraction of the total work done is stored, and what is the average horse-power exerted if the climb took 3 minutes?

7. An engine of 350 horse-power, whose weight is 20 tons, is attached to a train weighing 130 tons, and pulls it up an incline of 1 in 300 at a rate of 40 miles an hour. Find the resistance per ton due to friction, etc.

SPECIMEN ANSWERS TO TEST 18

1. A light string ABCD has one end fixed at A, and passing under a movable pulley of mass M at B and over a fixed pulley at C, carries a mass M' at D. The parts of the string are supposed vertical. Show that M descends with acceleration $(M - 2M')g/(M + 4M')$.



Let M have an acceleration f ft./sec^2. then M' has an acceleration -2f ft./sec^2., since the length of string CD decreases twice as fast as the distance AB increases. Let T poundals be the tension in the string, which is the same in all vertical parts.

Equations of motion are for mass M': $T - M'g = 2fM'$ .. .. (1)

for mass M: $Mg - 2T = fM$ .. .. (2)

Multiply equation (1) by 2 and add to (2)

$$\therefore \quad (M - 2M')g = (M + 4M')f$$

$$\therefore \quad f = \frac{M - 2M'}{M + 4M'} \cdot g$$

$\therefore$ Acceleration of M is $(M - 2M')g/(M + 4M')$.

2. On a cable railway a car, of weight $2\frac{1}{2}$ tons, is drawn up a slope of 1 in 10 from rest with an acceleration of 2 ft./sec^2. against a constant frictional resistance of $\frac{1}{2}$ cwt. Find the tension in the cable.

The component reaction due to gravity down the slope

$$= 2\tfrac{1}{2} \times 2240 \times \frac{1}{10} = 560 \text{ lbs.}$$

Force of friction down the slope = 56 lbs.

Total downward force = 616 lbs.

Let T lbs. be the tension in the cable and the accelerating force

$$= (T - 616) \text{ lbs.} = (T - 616)g \text{ poundals.}$$

This produces an acceleration of 2 ft./sec^2. in a weight of $2\frac{1}{2}$ tons.

$$\therefore \quad (T - 616)g = 2\tfrac{1}{2} \times 2240 \times 2$$

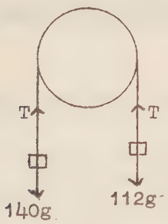
$$\therefore \quad T - 616 = \frac{5 \times 2240}{32} = 350$$

$$\therefore \quad T = 966 \text{ lbs.}$$

$\therefore$ Tension in cable = 966 lbs.

3. A man of 10 stone and a weight of 8 stone are suspended by means of a light rope over a smooth pulley. If the man pulls himself up by the rope so that his downward acceleration is g/18, find the

acceleration of the weight, and the acceleration of the man relative to the rope.



Let the man pull to give a tension T poundals in the rope and let f ft./sec^2. be the acceleration of the weight, while the acceleration of the man is $\frac{g}{18}$ downwards.

Equations of motion are:

$$\text{for weight} \quad 112f = T - 112g$$

$$\text{for man} \quad 140 \cdot \frac{g}{18} = 140g - T$$

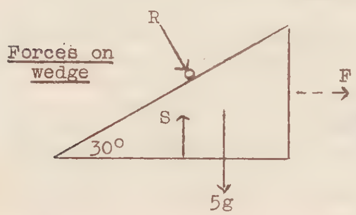
Add: $$112f + 140 \cdot \frac{g}{18} = 28g$$

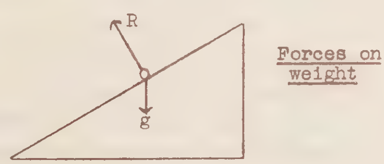
$$\therefore \quad 112f = 28g - \frac{70}{9}g = 20\frac{2}{9}g$$

$$\therefore \quad f = \frac{\cancel{182}^{13}}{\cancel{112}_8 \times 9} \cdot g = \frac{13}{72}g$$

Hence at point of suspension of the man the rope is moving downwards with an acceleration $\frac{13}{72}g$ and he is moving downwards with an acceleration $\frac{g}{18}$. Acceleration of man relative to rope downwards $= \frac{g}{18} - \frac{13}{72}g = -\frac{1}{8}g$, that is, $\frac{1}{8}g$ upwards.

A smooth wedge, weighing 5 lb., can slide on a smooth horizontal plane. A weight of 1 lb. is placed on the sloping face of the wedge 1 foot from the bottom edge, and allowed to slide down. If the angle of the wedge is 30°, and if the weight and wedge start from rest, prove that the weight reaches the bottom of the slope in about $\frac{1}{3}$ second.





Let acceleration of wedge be F ft./sec^2.

$$\therefore \quad 5F = R \sin 30^\circ \quad \ldots \quad (1)$$

$$\text{and} \quad 0 = S - 5g - R\cos 30^\circ \quad \ldots \quad (2)$$

Let acceleration of weight relative to the wedge be f ft./sec^2. down the plane.

$$\therefore \quad g \sin 30^\circ = f - F\cos 30^\circ \quad \ldots \quad (3)$$

$$\text{and } g\cos 30^\circ - R = F \sin 30^\circ \quad \ldots \quad (4)$$

From (1) and (4)

$$g\frac{\sqrt{3}}{2} - 10F = \frac{1}{2}F$$

$$\therefore \quad F = \frac{g\sqrt{3}}{21}$$

Hence, from (3)

$$f = \frac{1}{2}g + \frac{3g}{42} = \frac{4g}{7}$$

Hence, the time for the weight to reach the bottom of the plane is given by

$$1 = \frac{1}{2}\cdot\frac{4g}{7}\cdot t^2$$

$$\therefore \quad t = \sqrt{\frac{7}{64}} = \frac{\sqrt{7}}{8} = \frac{2{\cdot}646}{8}$$ which is approx. $\frac{1}{3}$ second.

5. Find the H.P. of an engine which pumps up water from a depth of 60 feet, and delivers it into an open tank at the rate of 500 gallons per minute through a cylindrical pipe of diameter 4 ins. (a gallon of water weighs 10 lbs. and its volume is 0·16 cubic feet).

Work done in raising 500 gallons through 60 feet

$$= 5000 \times 60 \text{ ft.lbs./minute.}$$

In addition, the water is given kinetic energy. The K.E. of the water issuing per minute

$$= \tfrac{1}{2}(5000)\,v^2 \text{ ft.pdls.,}$$

where v ft./sec. is the velocity of delivery from the pipe.

The velocity v can be found as follows:

$$\text{Volume issuing per sec.} = \frac{\pi}{4}\left(\frac{1}{3}\right)^2 v = \frac{500}{60} \times 0{\cdot}16 \text{ cu.ft.}$$

$$\therefore \quad v = \frac{50 \times 0{\cdot}16 \times 6}{\pi} = \frac{48}{\pi}$$

$$\therefore \text{Total work done per minute} = 300{,}000 + \frac{2500\left(\frac{48}{\pi}\right)^2}{32} \text{ ft.lbs.}$$

$$= 318{,}000 \text{ ft.lbs.}$$

$$\therefore \quad \text{H.P.} = \frac{318{,}000}{33{,}000} = 9{\cdot}7$$

6. A train of 350 tons is ascending an incline of 1 in 200, and the resistance to motion is 12 lbs. per ton. What is the acceleration of the train when its velocity is 15 m.p.h. if the H.P. then developed by the engine be 500?

$$\text{Component down incline due to gravity} = \frac{350 \times 2240}{200} = 3920 \text{ lbs.}$$

$$\text{Resistance at 12 lbs/ton} = 12 \times 350 = 4200 \text{ lbs.}$$

$$\therefore \quad \text{Total resistance} = 8120 \text{ lbs.}$$

Speed of 15 m.p.h. = 22 f.p.s. If the driving force at this speed = D lbs.wt., then

$$D \times 22 = 500 \times 550$$

$$\therefore \quad D = 12500$$

Let f ft./sec^2. be the acceleration. Then

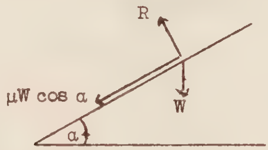
$$350 \times 2240f = (12500 - 8120)\,g$$

$$\therefore \quad f = \frac{4380}{350 \times 2240}\,g$$

$$= \frac{4380 \times 32}{350 \times 2240} = 0{\cdot}179 \text{ ft./sec}^2.$$

Hence acceleration = 0·18 ft./sec^2.

7. A particle is set moving with Kinetic Energy E straight up a rough inclined plane, of inclination α and coefficient of friction μ. Prove that the work done against friction before the particle comes to rest is $E\mu\cos\alpha/(\sin\alpha + \mu\cos\alpha)$. What is the condition that the particle, once reduced to rest, shall remain at rest?



The gravity component down the plane $= W\sin\alpha$

The normal component $= W\cos\alpha$

$\therefore$ frictional force down plane $= \mu W\cos\alpha$

$\therefore$ Total force down the plane $= W(\sin\alpha + \mu\cos\alpha)$

Let f ft./sec^2. be the retardation due to this force

$\therefore \quad Wf = W(\sin\alpha + \mu\cos\alpha)g \qquad \therefore \quad f = (\sin\alpha + \mu\cos\alpha)g$

If v ft./sec. be the initial velocity, then

$$\tfrac{1}{2}Wv^2 = E \quad \text{or} \quad v = \sqrt{\frac{2E}{W}}$$

Let s ft. be the distance from point of projection to the point where particle comes to rest.

$$\therefore \quad \frac{2E}{W} = 2(\sin\alpha + \mu\cos\alpha)gs \qquad [v^2 = 2fs]$$

$$\therefore \quad s = \frac{E}{W(\sin\alpha + \mu\cos\alpha)g}$$

But the force of friction $= \mu Wg\cos\alpha$

$$\therefore \text{ Work done against friction } = \frac{E}{W(\sin\alpha + \mu\cos\alpha)g} \times \mu Wg\cos\alpha$$

$$= \underline{\frac{E\mu\cos\alpha}{\sin\alpha + \mu\cos\alpha}}$$

If at the highest point the particle starts to move down the plane, the force of friction reverses its direction. The particle will therefore remain at rest if the gravity component is less than the limiting friction force,

i.e. $W\sin\alpha < \mu W\cos\alpha$ or $\underline{\tan\alpha < \mu}$.

E.W. ROBERTS, M.Sc.

(Revised: J. Topping, M.Sc., Ph.D., D.I.C., F.Inst.P.)

APPLIED MATHS. WOLSEY HALL, OXFORD LESSON 24

SET WORK

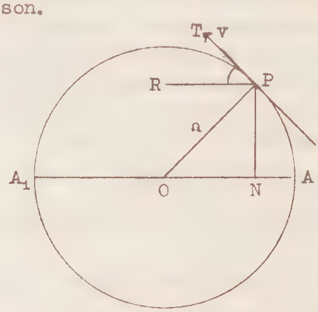
UBJECT: Simple Harmonic Motion.

READING: Humphrey & Topping; Chapter 8.

EXAMPLES: p.294, Nos. 1, 3, 4, 7, 9, 12, 19;
p.305, nos. 1, 3, 5, 7, 12, 16, 20;
p.313, nos. 1, 3, 5, 6, 9, 11.

NOTES

There are two methods of approach to this portion of the work which are now explained. The first establishes the relationship of Simple Harmonic Motion to motion in a circle with uniform speed, dealt with in the previous Lesson.



Let the point P move in a fixed circle of radius a with uniform speed v, to investigate the motion of N in the diameter AOA_1, where PN is always perpendicular to this diameter. For the point P, we know its velocity is a constant v along the tangent at P and its acceleration is $\frac{v^2}{a}$ along the radius PO. The point N will have a motion which is the projection of the motion of P on the diameter AOA_1.

The velocity of N $= v\cos RPT = v\sin PON = v.\frac{PN}{OP}$

$$= v.\frac{\sqrt{OP^2 - ON^2}}{OP} = \frac{v\sqrt{a^2 - x^2}}{a}$$

or, if we denote $\frac{v}{a}$ by ω (the symbol for angular velocity), the velocity of N $= \omega\sqrt{a^2 - x^2}$, where ON = x.

Again, the acceleration of N $= \frac{v^2}{a}.\sin OPN = \frac{v^2}{a}.\cos PON$

$$= \frac{v^2}{a}\cdot\frac{x}{a} = \left(\frac{v}{a}\right)^2 x = \underline{\omega^2 x}$$

From this it is seen that when $x = 0$, i.e. at the point O, the acceleration is zero; whereas when $x = \pm a$, the acceleration is either $+\omega^2 a$ or $-\omega^2 a$ and is directed towards O. On the other hand, at O the velocity is ωa and the velocity vanishes at both A and A_1. Thus the point N moves periodically between A and A_1, its acceleration being always directed towards the centre O and proportional to its distance from O. Furthermore, the point completes the cycle from A to A_1 and back again to A while the point P is describing

the whole circumference of the circle, and this takes a time $\frac{2\pi}{\omega}$. The motion of N is described as a simple harmonic motion of <u>amplitude</u> a (maximum displacement from the centre of oscillation) and <u>periodic time</u> $\frac{2\pi}{\omega}$ where the acceleration is directed towards the centre and equals ω^2 times the distance from the centre.

These results may be derived analytically as follows:

The motion is defined by the equation

$$\frac{d^2x}{dt^2} = -\omega^2 x = \frac{dv}{dt} = \frac{dx}{dt}\cdot\frac{dv}{dx} = v.\frac{dv}{dx}$$

or $\quad v.\frac{dv}{dx} = -\omega^2 x$

Integrate $\quad \therefore \frac{1}{2}v^2 = -\frac{1}{2}\omega^2 x^2 + C$

Now, if $x = \pm a$, $\quad v = 0 \qquad \therefore C = \frac{1}{2}\omega^2 a^2$

$$\therefore v^2 = \omega^2(a^2 - x^2) \quad \text{i.e.} \quad v = \omega\sqrt{a^2 - x^2},$$

which is the same result as obtained previously.

We can now proceed to find the periodic time by further integration. The equation is

$$\frac{dx}{dt} = \omega\sqrt{a^2 - x^2} \qquad \therefore \omega dt = \frac{dx}{\sqrt{a^2 - x^2}}$$

$$\therefore \quad \omega t = \int_0^a \frac{dx}{\sqrt{a^2 - x^2}},$$ the limits being taken from 0 to A to give the time taken to move from 0 to A.

$$= \left[\sin^{-1}\frac{x}{a}\right]_0^a = [\sin^{-1}.1 - \sin^{-1}.0] = \frac{\pi}{2}$$

$\therefore$ Time from 0 to A $= \frac{\pi}{2\omega}$ and hence time for complete oscillation $= \frac{2\pi}{\omega}$

Both of these methods are useful in the solution of problems and only experience teaches which method to adopt for any particular example.

EXAMPLE 1: A point is moving in a straight line with S.H.M. about a fixed point O of the line. The point has a velocity v_1 when its displacement from O is x_1 and a velocity v_2 when its distance from O is x_2. Show that the period of the motion is $2\pi\sqrt{\frac{x_1^2 - x_2^2}{v_2^2 - v_1^2}}$.

Let a be the amplitude of the motion and ω^2 the constant, then

$$\frac{d^2x}{dt^2} = -\omega^2 x \quad \text{and} \quad \frac{dx}{dt} = \omega\sqrt{a^2 - x^2}$$

When $x = x_1$ then $\frac{dx}{dt} = v_1 \qquad \therefore v_1 = \omega\sqrt{a^2 - x_1^2}$

When $x = x_2$ then $\frac{dx}{dt} = v_2 \qquad \therefore v_2 = \omega\sqrt{a^2 - x_2^2}$

Square and subtract $\qquad \therefore v_1^2 - v_2^2 = \omega^2(a^2 - x_1^2 - a^2 + x_2^2)$

$$\therefore \omega^2 = \frac{v_2^2 - v_1^2}{x_1^2 - x_2^2} \qquad \text{whence} \quad \omega = \sqrt{\frac{v_2^2 - v_1^2}{x_1^2 - x_2^2}}$$

and periodic time $T = \frac{2\pi}{\omega} = 2\pi\sqrt{\frac{x_1^2 - x_2^2}{v_2^2 - v_1^2}}$

EXAMPLE 2: A body, moving in a straight line OAB with S.H.M., has zero velocity when at the points A and B whose distance from O are a and b respectively, and has velocity v when halfway between them. Show that the complete period is $\pi(b-a)/v$.

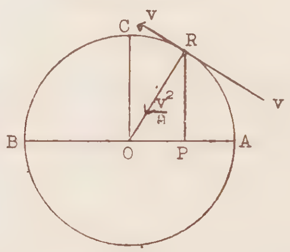
Clearly the centre of oscillation is C, the midpoint of AB, and the amplitude is CA or CB which equals $\frac{b-a}{2}$.

Now at C the velocity is v and, if ω^2 is the constant of the motion, then $v = \omega(\frac{b-a}{2})$ or $\omega = (\frac{2v}{b-a})$

$$\text{Hence periodic time} = \frac{2\pi}{\omega} = \frac{2\pi}{(\frac{2v}{b-a})} = \frac{\pi(b-a)}{v}$$

EXAMPLE 3: A point P moves in a straight line through a fixed point O in such a manner that its acceleration at each instant is towards O and equal to μOP; prove that the velocity is $\sqrt{\mu(OA^2 - OP^2)}$, where A is one of the points where P comes to rest.

If Q is the point on OA such that $2OQ^2 = OA^2$, show that the time from O to Q is the same as the time from Q to A.



If the point R moves in a circle of radius a with uniform speed v, then the acceleration is v^2/a along the radius RO. Let P be the projection of R on the diameter AOB. The acceleration of P in AOB is the projection of the acceleration of A

$$= \frac{v^2}{a} \times \frac{OP}{OR} = \frac{v^2}{a^2} \cdot OP \qquad \therefore \mu = \frac{v^2}{a^2}$$

i.e. the acceleration is proportional to OP, the distance from O
$\therefore$ P moves with S.H.M. in the diameter AOB.

Velocity of P is projection of velocity of R = $v \sin ROP$

$$= v \cdot \frac{\sqrt{OR^2 - OP^2}}{OR} = \sqrt{\frac{v^2}{a^2}(OR^2 - OP^2)}$$

$$= \sqrt{\mu(OA^2 - OP^2)} \quad \text{since } OA = OR.$$

If P is at Q so that $2OQ^2 = OA^2$, then $\frac{OQ}{OA} = \frac{1}{\sqrt{2}}$ and $\angle ROA = 45°$.

$\therefore$ arc CR = arc AR, and the point T moving with uniform speed in the circle takes the same time from A to R as from R to C. Hence the point P moving with S.H.M. in the diameter AOB takes the same time from O to Q as from Q to A.

EXAMPLE 4: A particle oscillates in S.H.M. on a line 6 inches long with a frequency of 2000 oscillations per minute. Calculate the greatest velocity and the greatest acceleration of the point each in ft./sec. units.

For this case, $a = 3$ ins. $= \frac{1}{4}$ ft.

Periodic time, $T = \frac{2\pi}{\omega} = \frac{60}{2000}$ sec.

$$\therefore \quad \omega = \frac{2\pi}{0\cdot03}$$

But the greatest velocity is at the centre of oscillation and equals

$$a\omega = \frac{2\pi \times 0\cdot25}{0\cdot03} = \underline{52\cdot34 \text{ ft./sec.}}$$

Again, the greatest acceleration is at the extreme points of the motion and equals

$$a\omega^2 = \left(\frac{2\pi}{0\cdot03}\right)^2 \times \frac{1}{4} = \underline{10966 \text{ ft./sec}^2.}$$

In order to produce a S.H.M. a force is required, since such a motion is accelerated. If the particle describing the motion has a mass m, then the force at any point, being equal to the mass × acceleration, is $-m\omega^2 x$, i.e. the force is proportional to the displacement. But in a previous Lesson it has been stated that for an elastic string the tension is proportional to the extension from its natural length. Thus a mass suspended from an elastic string describes a S.H.M. about an equilibrium configuration.

EXAMPLE 5: A mass m is suspended from a string causing an extension a. If a mass M is added to m, find the periodic time of the ensuing motion, and the amplitude of the oscillation.

Let l be the natural length of the string and λ the modulus of elasticity.

$$\therefore \quad mg = \lambda \cdot \frac{a}{l} \qquad \therefore \quad \lambda = \frac{mgl}{a}$$

If the mass $(M + m)$ produces an extension x, then

$$(M+m)g = \lambda \cdot \frac{x}{l} \qquad \therefore \quad x = \frac{(M+m)gl}{\lambda} = \frac{(M+m)a}{m}$$

and the amplitude of the oscillation is

$$x - a = \frac{(M+m)a}{m} - a = \underline{\frac{M}{m} \cdot a}$$

The tension in the string $= \lambda \cdot \frac{x}{l} = \frac{mgl}{a} \times \frac{x}{l} = \frac{mx}{a} g$

The mass to be accelerated is $(M + m)$

$$\therefore \quad \text{acceleration} = \frac{mgx}{a(M+m)}$$

Hence the constant of the oscillation $= \sqrt{\frac{mg}{a(M+m)}}$

$$\therefore \quad \underline{T = \frac{2\pi}{\omega} = 2\pi\sqrt{\frac{(M+m)a}{mg}} \text{ seconds.}}$$

EXAMPLE 6: A spiral spring supports a carrier weighing 1 lb., and when a 5 lb. weight is placed on the carrier the spring extends 2 inches. The carrier with its load is pulled down a further distance of 2 ins. and is then let go. How far does it rise, and what is the greatest velocity it attains?

Let l be the natural length of the spring and λ its modulus of elasticity. The carrier of weight 1 lb. has extended it a distance x ft. and a further 5 lb. extends it a further distance of 2 inches $= \frac{1}{6}$ ft.

$$\therefore \quad g = \lambda\frac{x}{l}$$

$$\text{and} \qquad 6g = \lambda\frac{\frac{1}{6}+x}{l}$$

Subtracting $\therefore \ 5g = \frac{\lambda}{6l}$ or $\lambda = 30gl$

and substituting in the first equation $x = \frac{1}{30}$ ft.

When extended a further 2 inches, i.e. a total of $(\frac{1}{3} + \frac{1}{30}) = \frac{11}{30}$ ft.,

$$T = \lambda\frac{\frac{11}{30}}{l} = 30gl \times \frac{11}{30l} = 11g$$

$\therefore$ accelerating force $= 11g - 6g = 5g$ poundals and mass to be moved is 6 lb.wt.

$\therefore$ acceleration at lowest point is $\frac{5g}{6}$ ft./sec^2.

Now the amplitude of the motion is clearly 2 inches $= \frac{1}{6}$ ft., and if ω^2 is the constant of the oscillation,

$$\frac{1}{6}\omega^2 = \frac{5g}{6} \quad \therefore \ \omega^2 = 5g = 160 \quad \therefore \ \omega = 4\sqrt{10}$$

Again, maximum speed = amplitude × $\sqrt{\text{constant}}$

$$= \frac{1}{6} \times 4\sqrt{10} = \underline{\frac{2}{3}\sqrt{10} \text{ ft./sec.}}$$

<u>The weight will clearly rise a distance of 4 inches.</u>

The most important simple application of S.H.M. is to the case of a simple pendulum. Here a small mass is suspended from a fixed point by an inextensible string. When the oscillations are small on each side of the vertical, it is shown that the motion of the mass approximates to S.H.M. You will find this fully explained in § 8.11, the contents of which paragraph you should be able to reproduce.

After reading §§8.12, 8.13 and studying carefully the worked-out examples, you should leave the remainder of the chapter.

EXAMPLE 7: A seconds pendulum is carried down with a lift at an uniform acceleration of 2 ft./sec^2.; at the rate of how many seconds an hour will it lose?

When descending at an acceleration of 2 ft./sec^2. the gravitational field on the pendulum is $32 - 2 = 30$ ft./sec^2.

As l is the length of a seconds pendulum

$$2\pi\sqrt{\frac{l}{32}} = 2$$

$$\therefore \quad 2\pi\sqrt{\frac{l}{30+2}} = 2 \qquad \therefore \quad 2\pi\sqrt{\frac{l}{30(1+\frac{1}{15})}} = 2$$

$$\therefore \quad 2\pi\sqrt{\frac{l}{30}} = 2(1+\tfrac{1}{15})^{\frac{1}{2}} = 2(1+\tfrac{1}{30}) \text{ to first approximati}$$

$$\therefore \quad \text{loss} = \frac{3600}{30} = \underline{120 \text{ seconds/hour.}}$$

EXAMPLE 8: A simple pendulum making small oscillations is allowed to swing from a position in which it makes α° with the vertical. if v is the maximum speed, show that the complete period is $\frac{45v}{4\alpha^\circ}$ seconds.

We know that the maximum speed is given by

$$v^2 = 2gl(1 - \cos\alpha)$$

and when α is small this may be written

$$v^2 = 2gl(1 - 1 + \frac{\alpha^2}{2}), \quad \underline{\text{where } \alpha \text{ is in radians}}$$

$$= gl\alpha^2$$

$$\therefore \quad v = \alpha\sqrt{gl}$$

$$= \frac{\pi\alpha^\circ}{180}\sqrt{gl}$$

If a is the amplitude and ω^2 the constant of the S.H.M.,

$$\therefore \quad a\omega = v = \frac{\pi\alpha^\circ}{180}\sqrt{gl}$$

$$\text{But} \quad a = \frac{\pi l\alpha^\circ}{180} \qquad \therefore \quad \omega = \sqrt{\frac{g}{l}} = \frac{\pi\alpha^\circ g}{180v}$$

$$\therefore \quad \text{Periodic Time} = T = \frac{2\pi}{\omega} = \frac{2\pi \times 180v}{\pi\alpha^\circ g} = \underline{\frac{45v}{4\alpha^\circ} \text{ seconds.}}$$

T E S T 24

1. A particle performs 150 complete simple harmonic oscillations a minute and its greatest acceleration is 10 ft./sec^2; find (i) its greatest speed, (ii) its mean speed during the motion from one extreme position to the other.

2. On a given day the depth at high water over a bar is 32 ft. and at low water $6\frac{1}{4}$ hr. earlier it is 21 ft. If high water is at 3.20 p.m., what is the earliest time that a ship drawing $28\frac{1}{2}$ ft. can cross the bar? (Assume that the level of the water changes with S.H.M.).

3. A mass of 5 lb. is hung from a light string and is found to stretch it 4 in.; it is then pulled down a further 2 in. and released. Find the time of a complete oscillation and calculate the kinetic energy of the mass when passing through the position of equilibrium.

4. A smooth airless tunnel is bored through a diameter of the earth. Find the time taken to slide through, and the speed at the centre.

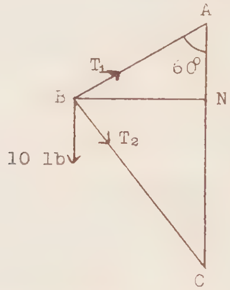
5. A balloon ascends with constant acceleration, and reaches a height of 900 ft. in one min.; show that a pendulum clock carried in it will gain at the rate of about 28 sec. per hour.

6. A point describes a line AB with S.H.M. If C divides AB in the ratio 3 : 1, show that the point takes twice as long to describe AC as to describe CB.

7. In a S.H.M., after the moving point is 3 ins. from the mid-point of its path, moving away from it, 4 secs. elapse until it is again in that position moving towards the centre, and a further 10 secs. until it is there again. Find the length of the path.

SPECIMEN ANSWERS TO TEST 23

1. Two perpendicular light rods AB,BC are connected to a mass of weight 10 lbs. at B, and have the ends A,C jointed to a fixed vertical spindle AC (A above C). If AC is 2 ft., the angle CAB = 60° and the mass rotates about AC with a speed of 3 ft./sec., find the tensions in the rods AB,BC.



The mass of 10 lbs. moves on a circle of radius BN, where BN is perpendicular to AC. Since the angles at A and C are 60° and 30° respectively,

$$AN = \frac{BN}{\sqrt{3}} \quad \text{and} \quad CN = BN.\sqrt{3}$$

$$\therefore \quad AC = 2 = AN + CN = BN(\sqrt{3} + \frac{1}{\sqrt{3}}) = \frac{4}{\sqrt{3}}.BN$$

$$\therefore \quad BN = \frac{\sqrt{3}}{2} \text{ ft.}$$

$\therefore$ Central acceleration of 10 lb. mass $= \dfrac{3^2}{32 \times \frac{\sqrt{3}}{2}} = \dfrac{3\sqrt{3}}{16}$ ft./sec^2.

Let T_1, T_2 lb.wt. be the tensions in AB,BC, then equations for B are:

$$10 = T_1 \cos 60^\circ - T_2 \cos 30^\circ = \tfrac{1}{2}T_1 - \tfrac{\sqrt{3}}{2}T_2 \quad \ldots \ldots \ldots (1)$$

and $$10.\frac{3\sqrt{3}}{16} = T_1 \sin 60^\circ + T_2 \sin 30^\circ = \frac{\sqrt{3}}{2}T_1 + \tfrac{1}{2}T_2 \quad \ldots \ldots \ldots (2)$$

Multiply (1) by $\sqrt{3}$: $\quad \therefore \quad 10\sqrt{3} = \frac{\sqrt{3}}{2}T_1 - \frac{3}{2}T_2$

Subtract: $\quad \therefore \quad \frac{15}{8}\sqrt{3} - 10\sqrt{3} = 2T_2$

$$\therefore \quad T_2 = -\frac{65}{16}\sqrt{3} \text{ lbs.}$$

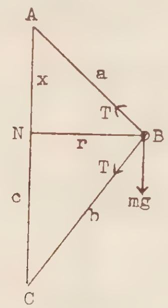
and from (1): $\frac{1}{2}T_1 = 10 + \frac{\sqrt{3}}{2}T_2 = 10 - \frac{195}{32} = \frac{125}{32}$

$$\therefore \quad T_1 = \frac{125}{16} \text{ lbs.}$$

2. A fine string passes through a smooth ring and has its ends fixed at two points in the same vertical line a distance c apart. If the ring be whirled round so that it describes a horizontal circle with uniform angular velocity ω, show that

$$2(a+b)gc = \omega^2[(a+b)^2 - c^2](a-b),$$

where a,b are the lengths of the two parts of the string.



Since the ring is smooth then the tension T in the portions AB,BC are equal. Let the distance BN from AC be r and AN be x when CN = c − x. If AB = a and BC = b, we have the force acting on the ring towards N

$$= T\left(\frac{r}{a} + \frac{r}{b}\right)$$

$$= \frac{Tr(a+b)}{ab}$$

and we have the equation

$$m\omega^2 r = \frac{Tr(a+b)}{ab} \quad \ldots\ldots\ldots\ldots \quad (1)$$

From the vertical equilibrium of the ring,

$$T.\frac{x}{a} = mg + T\frac{c-x}{b}$$

$$\therefore \quad T\left(\frac{x}{a} - \frac{c-x}{b}\right) = mg \qquad \text{i.e.} \quad T.\frac{bx - ac + ax}{ab} = mg$$

$$\therefore \quad T = \frac{ab}{x(a+b) - ac}.mg$$

Substitute in (1):

$$\therefore \quad \frac{\omega^2}{g} = \frac{(a+b)}{x(a+b) - ac}$$

But from figure, $r^2 = a^2 - x^2 = b^2 - (c-x)^2$

$$\therefore \quad a^2 - b^2 + c^2 = 2cx$$

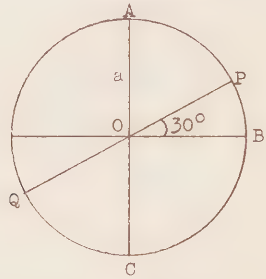
$$\therefore \quad x = \frac{a^2 - b^2 + c^2}{2c}$$

$$\frac{\omega^2}{g} = \frac{(a+b)}{\frac{(a+b)(a^2-b^2+c^2)}{2c} - ac} = \frac{2c(a+b)}{(a+b)(a^2-b^2)+ac^2+bc^2-2ac^2}$$

$$= \frac{2c(a+b)}{(a-b)[(a+b)^2 - c^2]}$$

$$\therefore \quad \omega^2(a-b)[(a+b)^2 - c^2] = 2gc(a+b) \quad \text{as required.}$$

3. A heavy particle in a smooth circular tube in a vertical plane is slightly displaced from rest at the top. Find the ratio of the pressures as the particle passes the end of the horizontal diameter and the lowest point. What are the pressures at the ends of a diameter inclined at 30° to the horizontal?



Let m be the mass of the particle. Since the particle is at rest originally, the velocity along the tangent at B is that due to a fall through a distance OA = $\sqrt{2ga}$, and velocity along the tangent at C is that due to a fall through AC = $\sqrt{2g \times 2a} = 2\sqrt{ga}$.

$$\therefore \quad \text{Central acceleration at B} = \frac{(\sqrt{2ga})^2}{a} = \frac{2ga}{a} = 2g$$

$\therefore$ Pressure on the particle at B = 2mg.

Since at B the weight of the particle acts along the tangent to the tube

$$\text{Central acceleration at C} = \frac{(2\sqrt{ga})^2}{a} = 4g$$

and hence the pressure on the particle at C = 4mg + mg = 5mg.

Hence ratio of the pressures at B and C is 2 : 5.

Again, velocity along tangent at P is that due to a fall through a distance $\frac{a}{2}$ and equals $\sqrt{ga}$.

$$\text{Hence central acceleration at P} = \frac{(\sqrt{ga})^2}{a} = g$$

and gravity component acting towards the centre O = mg cos 60°.

$= \frac{1}{2}$mg

Hence, if R is the reaction on the particle, R+$\frac{1}{2}$mg = mg

$\therefore$ R = $\frac{1}{2}$mg

$\therefore$ Nett inward pressure = $\frac{1}{2}$mg at P.

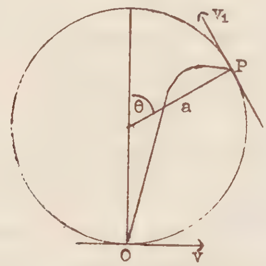
At the point Q the velocity along the tangent is due to a fall through $\frac{3}{2}a$ and equals $\sqrt{3ga}$.

$\therefore$ The central acceleration $= \frac{(\sqrt{3ga})^2}{a} = 3g$

The gravity component equals $\frac{1}{2}mg$ outwards,

$\therefore$ Nett inward pressure on the particle $= 3\frac{1}{2}mg$ at Q.

4. A particle suspended by a vertical string is projected horizontally, and after describing an arc of a circle the string slackens and the particle moving in a parabolic path returns to the point of projection. Prove that the string is inclined at 60° to the vertical when it first becomes slack.



Let v_1 be the speed at the point where the particle leaves the circle,

$$\therefore \quad m\frac{v_1^2}{a} = mg\cos\theta \quad \text{or} \quad v_1 = \sqrt{ag\cos\theta}$$

This is the velocity of projection for the parabolic path from P to O and its components are $v_1\cos\theta$ horizontally and $v_1\sin\theta$ vertically. In moving from P to Q the particle moves distances $a\sin\theta$ and $-a(1+\cos\theta)$ in these two directions. Let the time taken be t seconds,

$$\therefore \quad -a(1+\cos\theta) = v_1\sin\theta.t - \tfrac{1}{2}gt^2 \quad \ldots\ldots\ldots \quad (1)$$

$$\text{and} \quad \sin\theta = v_1\cos\theta.t \quad \ldots\ldots\ldots\ldots\ldots \quad (2)$$

From (2): $\quad t = \frac{a}{v_1}\tan\theta$

Substitute in (1):

$$\therefore \quad -a(1+\cos\theta) = a\tan\theta.\sin\theta - \frac{1}{2}g.\frac{a^2}{v_1^2}\tan^2\theta$$

But $v_1^2 = ag\cos\theta$

$$\therefore \quad -a(1+\cos\theta) = \frac{a\sin^2\theta}{\cos\theta} - \frac{a}{2}\frac{\sin^2\theta}{\cos^3\theta}$$

Multiply by $\cos^3\theta$ and divide by a.

$$\therefore \quad -\cos^3\theta - \cos^4\theta = \sin^2\theta\cos^2\theta - \tfrac{1}{2}\sin^2\theta$$

$$\text{i.e.} \quad -\cos^3\theta - \cancel{\cos^4\theta} = \cos^2\theta - \cancel{\cos^4\theta} - \tfrac{1}{2} + \tfrac{1}{2}\cos^2\theta$$

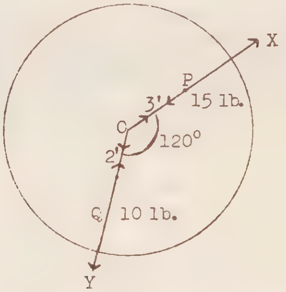
$$\therefore \quad 2\cos^3\theta + 3\cos^2\theta - 1 = 0$$

$$\text{i.e.} \quad (2\cos\theta - 1)(\cos^2\theta + 2\cos\theta + 1) = 0$$

$$\therefore \quad \cos\theta = \tfrac{1}{2} \quad \text{or} \quad \theta = 60^\circ$$

Hence particle leaves the circle when the angle of string to vertical is 60°.

7. A mass of 15 lb. is bolted to one of the spokes of a flywheel, its centre of gravity being 3 ft. from the centre of the wheel. Another mass of 10 lb. is bolted to another spoke, with its centre of gravity 2 ft. from the centre of the wheel. The angle between the two spokes is 120°. Find the resultant force on the bearings of the flywheel due to the inertia of these masses, when the wheel is rotating uniformly at 240 revolutions per minute.



240 revolutions is equivalont to an angular velocity of $\frac{240 \times 2\pi}{60}$ $= \underline{8\pi \text{ radians/second}}$.

$$\therefore \quad X = \text{force due to 15 lb. mass at 3 ft. arm}$$

$$= \frac{15 \times (8\pi)^2 \times 3}{32} = 90\pi^2 \text{ lb.}$$

$$\text{and} \quad Y = \text{force due to 10 lb. mass at 2 ft. arm}$$

$$= \frac{10 \times (8\pi)^2 \times 2}{32} = 40\pi^2 \text{ lb.}$$

$$\therefore \quad \text{Resultant} = \sqrt{X^2 + Y^2 + 2XY \cos 120^\circ}$$

$$= \sqrt{(90\pi^2)^2 + (40\pi^2)^2 + 2(90\pi^2)(40\pi^2)(-\tfrac{1}{2})}$$

$$= 10\pi^2\sqrt{81 + 16 - 36} = 10\pi^2\sqrt{61} = \underline{770 \text{ lbs.}}$$

E.W. ROBERTS, M.Sc.

(Revised: J. Topping, M.Sc., Ph.D., D.I.C., F.Inst.P.)

5. A car travels round a curve on a track of 50 yards radius at a speed of 30 m.p.h. Show that if there is no side-pressure between the car and the track, the track must be banked at an angle of approximately 22°.

What would be the side-pressure if a car weighing 1 ton went round this curve at a speed of 45 m.p.h.?

Let m be the mass of the car. 30 m.p.h. = 44 f.p.s.

∴ Centrifugal force acting through C.G. of the car horizontally and outwards $= \frac{m \times (44)^2}{150 \times 32} = \frac{121m}{300}$ lbs.

If the track be banked through an angle θ, then component of centrifugal force up the bank $= \frac{121}{300} m \cos\theta$, and gravity component inwards down the bank $m \sin\theta$. If side-pressure vanishes, then

$$m \sin\theta = \frac{121m}{300}\cos\theta \qquad \therefore \tan\theta = \frac{121}{300} = \cdot 403$$

$$\therefore \theta \doteqdot 22^\circ$$

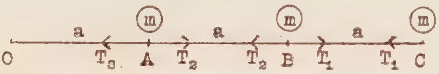
If m = 2240 lbs. and v = 45 m.p.h. = 66 f.p.s., then

$$\text{side-pressure} = \frac{2240 \times (66)^2}{150 \times 32}\cos 22^\circ - 2240 \sin 22^\circ$$

$$= \frac{2240 \times (66)^2}{150 \times 32} \times 0\cdot 9272 - 2240 \times 0\cdot 3746$$

$$= 1885 - 839 = \underline{1046 \text{ lbs.}}$$

6. A loaded rod OABC (OA = AB = BC = a), with masses m at A,B,C, rotates about O in a horizontal plane, the masses being on a smooth table. Find the ratios of the tensions in OA,AB,BC.



The mass m at C is at the end of an arm of 3a and if ω is the angular velocity of the rod about O, then

$$\text{Tension in BC} = \underline{\frac{3am\omega^2}{g}}$$

The mass m at B is at the end of an arm 2a and is subject to forces T_2 and T_1.

$$\therefore \quad T_2 - T_1 = \frac{2am\omega^2}{g}$$

$$\text{Hence Tension in portion AB} = \frac{2am\omega^2}{g} + \frac{3am\omega^2}{g} = \underline{\frac{5am\omega^2}{g}}$$

The mass m at A is at the end of arm a, and is subject to forces T_3 and T_2.

$$\therefore \quad T_3 - T_2 = \frac{am\omega^2}{g}$$

$$\therefore \quad \text{Tension in portion OA} = \frac{am\omega^2}{g} + \frac{5am\omega^2}{g} = \underline{\frac{6am\omega^2}{g}}$$

<u>Hence ratios of tensions in OA, AB, BC are 6 : 5 : 3.</u>

APPENDIX IV

THE PHD IN INDUSTRY

A. Introduction

(a) Establish the bonafides of the lectures - use Exhibit I.

(b) Discuss what a PhD is.

(c) Investigate what a PhD normally does when he enters industry.

1. What is Industry

A coordinated and planned activity involving a relatively large number of individuals which is designed to be self-sustaining in that it

(i) makes a profit sufficient to pay off the service charges on the capital involved (dividends can be regarded in this light).

(ii) changes its business as appropriate so that the product or service that the business produces is still in demand.

2. What is a PhD

A Doctor of Philosophy

Doctor - skilled and qualified to teach
- a certificate of the highest proficiency in a given subject
- an eminently learned man

Philosophy - the love, study and pursuit of wisdom or of knowledge of things and their causes whether theoretical or practical

3. Entering Industry a PhD May

(i) become an assistant to an executive in some administrative capacity

(ii) become a trainee in some department, e.g. sales or market research

(iii) if scientifically trained, may enter a research and development department or the technical department of a manufacturing or service industry

For the moment I propose to neglect (a) and (b) as trivial cases, though I will be happy to deal with them in the discussion, and I will concentrate on (c). Professor S. G. Mason states:

> "conceiving and performing research is what I think he should do (at least in the early stages) when he joins industry; in later years he may elect to become involved in administration and management but this should only be after he has considerable creative accomplishment under his belt."

I propose to deal with the subject of the PhD in technical work by the reverse method of discussing the "rules of the game" of technical work. This I have done for two reasons.

First of all, these rules are very poorly understood both by technical men in industry and by the management and supervisors of technical work. An exposition of these principles, may therefore, be genuinely helpful to many of you in your professional careers.

Secondly, having examined the rules for conducting technical work we can then go back and see how the possession of a PhD makes the individual more or less suitable for work in industry and how he should be expected to conduct himself in a manner which will be profitable to his employer whilst at the same time advancing his own career.

The Rules of the Game

These are most easily studied on the basis of fifteen premises which I will list and discuss.

Premise 1 Productive research depends on the existence in the department of one or more men of genuine creative talent, one of whom must be in a senior position.

Premise 2 Judgment of the talented research director is the yardstick by which the operation must be guided and in the short term assessed.

Premise 3	Financial assessments are only truly representative over a long period.
Premise 4	The wild "scientific management" methods proposed for research by such organizations as the various schools of business administration are useless.
Premise 5	Service work and research work must be effectively separated.
Premise 6	A carefully thought out mechanism is necessary for implementation of development work, which must be carefully distinguished from research work.
Premise 7	All available information originating from inside and outside the research department should be utilized.
Premise 8	The proper working conditions must be provided so that creative research men of the first rank will join the research organization <u>and will stay</u>.
Premise 9	The staff must be trained.
Premise 10	The administration must be first class; it must support the scientists so that the latter are free from unnecessary administrative detail and can get on with the work.
Premise 11	Projects must be selected with discrimination, written out to illustrate scope and objectives and planned thoroughly.
Premise 12	The men working on a project must be protected from interruption.
Premise 13	The supervision must be kept in touch with all work in progress so that guidance is available when needed.
Premise 14	The correct reporting discipline must be established.
Premise 15	Every project must be finished off to a logical stopping point, and written up so that useful results are available later, even though the original urgency may no longer exist.

C. What Does the Job in Industry Demand

(Assuming that the company is the right one)

If the PhD is about to enter the R and D field or something equivalent, it demands:

(a) An ability to see what everyone else has seen and think what no one else has thought (Szent Gyorgi).

Polyani expressed this in other words as:

> "The distinctive ability of a scientific discoverer lies in the capacity to embark successfully on lines of enquiry which other minds faced with the same opportunity would not have recognized or would not have thought profitable."
>
> (Reference 1)

(b) The ability to seize on the essentials of a problem, even if the man propounding it cannot do so.

(c) The ability to plan work, organize it and carry it through.

(d) Meticulous attention to scientific discipline method and ethics.

D. What Does the PhD Have to Offer to Meet the Above

Let us examine the training to which a PhD has been subjected. This is in two parts:

(a) The formal course work to develop a proficiency in his area of study - see Wilder's letter for comment on this.

(b) The research part -- an exercise in problem solving. -- following Dr. D. W. Manson

For his thesis he must identify a problem, find out what is already known about it, develop a hypothesis on how the problem should be worked out, find what more he needs to know to prove the hypothesis, devise a means of getting the information, analyze it and draw valid conclusions.

Manson summarized the PhD's qualifications after all this as:

(a) Higher than average intelligence

(b) A degree of tenacity

(c) Advanced training in one or two disciplines

(d) A proven ability to solve problems or at least a knowledge of how to go about it

E. What Has the PhD Got Against Him

(a) He has not learnt how large a part of industry may not respond to scientific treatment.

(b) The starting salaries of PhD's ($13,000 in U.S.A. this year) are bid so high that these men must immediately get supervisory positions.

Thus, we end up with a group of very specialized men trained in narrow areas.

With no experience these men cannot be put into production and even in research the high salary is a problem.

(c) Possibility of viewing PhD as a licence to practice intellectual snobbery.

F. Why Should the PhD be Restricted to Research

One of my distinguished colleagues has expressed this as follows:

Facets other than research are a waste of talent. For example, in production the PhD generally does not have the tools for the job. A PhD's method of evaluating production problems are often contrary to the type of action man required. In all the restrictions or limitations to which the PhD is subject the post-graduate training can be considered as the root cause.

It can be, and is, argued by many that the narrow and specialized scope of the PhD thesis program causes the student to lose the broad spectrum and outlook that he previously had gained from his undergraduate work.

In what areas of research should the PhD work? Fundamental, development or applied? And what can one say of his role in these various avenues of research?

In Canada and the U.S. most fundamental studies still take place either in centralized research centers or in universities. The progress of any industry depends on understanding how and why certain phenomena occur and by means of this understanding realizing how processes and products can be improved. The PhD is considered by many to be in his true role finding out these hows and whys - a role he has been well trained for. The PhD is, thus, considered to be best employed in fundamental research - in industry where the company really does any, in institutes and in the universities.

When involved in development work, the PhD guides the stage beyond basic work. Here he will be involved with bringing along the original concept, e.g. by model studies. At this juncture many consider that the PhD begins to fade because they are "second best" at projecting or applying basic work again due to the training they have received.

Today PhD's are being thrust into the top positions of research groups almost before they have encountered "one round of fire" and certainly before they have "won their spurs". Generally the PhD finds himself assuming an increasing role as an administrator which is a complete waste of talent or as a director trying to organize all phases of a research group and having a devil of a time in the application of research projects.

G. My Own Viewpoint

My own views are liable to cause some controvery and, therefore, I thought it advisable to give some background and discuss the views of others, including those contained in the two handouts.

"Engineering education has become progressively more theoretical and abstract whilst at the same time engineering achievement must be ultimately expressed in terms of hardware. At present the period of transition from theory to practice tends to be relegated to a post university industrial training period. In this the best method or ought the universities be doing more to bring the students down to earth?"

(a) My own view summarizes and reinforces those of my past colleagues so far quoted.

1. The PhD has been trained to think, to plan and carry to a successful conclusion experimental work.

2. He has not been trained to be creative because this is something one cannot train for, one can merely develop the latent capacity.

3. He may or may not have good project selection judgment.

(b) My belief is that Phd's should be used for jobs in which their thinking capacity and work tenacity are applicable.

To use PhD's for this in industry requires often that they are willing and able to understand the process - this means hard and sometimes very hard work.

(c) The PhD should not be used in some narrow area of speciality because he happens to have studied it.

(d) The PhD is the mirror of the supervisor.

(e) My complaint regarding PhD's is that they:

1. Do wish to continue doing what they were doing before, they consider that industry should be an extension of university.

2. Often feel that they are entitled to a supervisory position without proving their merit and worth.

3. Do not wish to thoroughly familiarize themselves with the process.

There is a place for PhD's in industry, either in R and D or in other technical areas of a process company if the above three do not hold - if they do, the PhD will either be a relative nomentity or very unhappy.

H. Positions Other Than R and D (ack to JPF)

In general terms, my colleagues and I consider that what industry needs today in all branches (including sales) is men with ability to think clearly and logically. This is, of course, especially true on the production side if one is to get away from the traditional method of handling situations based on purely personal experience and a rather empirical approach.

A successful production man in many industries needs a good knowledge of engineering in order to control what is often to a surprising extent, an engineering operation. Allied with the engineering approach is needed good training in logical thought processes a subject not normally taught in universities and which may or may not be taught in a particular science.

A useful training to provide this background in logic would be mathematics.

One may deduce from this that a science PhD is not the best basic training for a management man. This is a generalization that must be carefully avoided.

What really matters is the personality and the brainpower of the individual. For some persons a PhD may be the most useful training or step in their life's progression; for others some quite different training may be more appropriate.

The real value of a PhD with regard to the considerations advanced above lies in the personal contacts that he has had with the man who directs his work. If the director of studies has had a good training then the experience will be invaluable. On the other hand, there is absolutely no value in obtaining a doctorate for its own sake and believing that in some magic way this will open the door to great opportunities.

This places a very great responsibility upon those who choose men who set out on the road that leads to a PhD and they should be prepared to accept an alternative course even if they are desperately in need of research students.

I. <u>How Should a PhD Choose A Company</u>

So far we have been discussing, from somewhat diverse points of view, how a PhD fits into the industrial world. It is appropriate to continue with some comments on how should a PhD choose a company.

If those of us who have contributed to the talk have any reason to back our beliefs that we understand the relationship between the PhD and industry then we should be able to offer constructive and useful advice on choosing a company.

(a) We should first of all, assume that the companies in question have provided such facts as are needed about the organization, including copies of past annual reports and details of the location of the companies' manufacturing facilities, together with their size and other appropriate information and of the laboratory and research organizations.

It is presumed that the graduate has verified and compared such facts as have been presented.

(b) Many companies suffer from a security mania and publish nothing. In my professional life, I have not infrequently gained access to the available data in such companies and found that the world was no poorer as a result of the decision because there was nothing worthy of publication - the only people who had been fooled had been the company management!!

It is, therefore, appropriate that the interviewee or candidate request a list of publications that have originated from the company in the last ten years and in addition, ask for a list of publications that may have originated from the outstanding men the company may now have working for them.

(c) Find out how many good men in the technical or scientific field have been produced by the company in the past ten or twenty years - can these be traced back to any one or two individuals.

Here it is perhaps worth digressing to note that when interviewing people for positions of intermediate seniority, one searches for what they may have done, the idea being that if over the years they have not produced for someone else they are not likely to produce for you.

However, when interviewing people for very senior positions, the unspoken question is different; it is "How many good men have you trained?" The point is that the man's professional capability is now taken for granted or he would not have got so far in the interviewing process. One is concerned to obtain a man of the highest caliber and men of this caliber are "compulsive trainers" both of themselves and of others.

(d) Visit the company laboratory or plant and find out the spirit, the morale, that exists. Whilst there DO NOT

1. Waste too much time on salary; they know the going rate or if they do not then they are too foolish to consider.

2. Waste too much time on pension plans, etc. You are fit and nearly forty years from retirement; most companies have an adequate plan. In forty years:

(i) you won't be working for X and Y anyway

(ii) the plan will be all changed

DO

1. Check on the publications - try to see the men who wrote the ones that interested you; be prepared for a first class discussion if you meet them.

2. Try to meet the men who have trained other good men.

3. Try to find someone a few years ahead of you (from the same school?) with whom you can talk - ask for this if they are keen and confident they will find someone.

4. Generally estimate the quality of your possible future associates. If they are good and have stayed then conditions are probably satisfactory.

q Conditions include:

1. reasonable degree of freedom of action

2. non-interferring administration

3. reasonable equipment provision

4. library facilities

5. proper working space

6. proper research management and direction (very much rarer than commonly realized).

7. adequate compensation

8. proper policy with regard to attendance at technical meetings (this is <u>always</u> related to publication policy which we have already found out about)

5. Check career advancement opportunities.

6. And most important of all, make sure you meet and evaluate the man you will be working for. At this stage in your career, he is the man who will have more influence on you than anyone since your mother. You are, in fact, about to be "born again".

J. Conclusions

I have tried this afternoon to convey to you a synthesis of the thoughts of about a dozen men, all of whom by any standard but their own, would be considered as very successful, on the place of the PhD in industry.

Regretfully, I must concur with the majority of my colleagues that the PhD finds his best use initially in the research department of a large company. However, as you can see from the tables which show the fate of PhD's from two graduate schools, they end up in a wide variety of positions.

My own view is that the training of a PhD is perhaps of more use to the individual, and produces a man more easily usable in industry if it is entered on following several years of work in industry, instead of directly following the Bachelors degree.

See Exhibit III.

1. Selection and Evaluation of Research Projects
   Hitchcock, L. B.
   Research Management VI 3; 231-245 (1963)

2. Reflections on the PhD Interview
   Van Raalter, J. A.
   Research Management IX 5; 307-317 (1966)

TABLE I

DISTRIBUTION OF GRADUATES SCHOOL A

	TOTAL	PERCENT
In University Work	46	15
In Government Work	45	15
Industry (Class A)	71	24
(Class B)	36	12
(Class C)	50	17
(Class D)	8	3

TABLE II

DISTRIBUTION OF GRADUATES SCHOOL B

	FIRST 10	INTER 18	LAST 5	TOTAL
General Administration				
Board Chairman	1	-	-	1
President	4	3	-	7
Executive Vice-President	3	-	-	3
Vice-President	4	8	-	12
General Manager	3	4	-	7
Management Staff	8	1	-	9
				39
Production				
V.P. Manufacturing	4	1	-	5
Production Manager	2	9	1	12
Mill Manager	3	6	1	10
Production Staff	1	3	3	7
				34
Eng. & Tech. Service				
Chief Engineer	-	2	-	2
Tech. Services Mgr.	9	18	3	30
Asst. Tech. Services Mgr.	-	8	1	9
Chemist or Engineer	-	3	12	15
				56
Research & Development				
V.P. Research & Development	3	6	-	9
Director Corp. Research	3	6	-	9
Dir. or Asst. Dir. of Res.	4	11	2	17
Sect. or Group Leader	11	29	6	46
Res. Chemist or Eng.	1	9	32	42
				123
Educational & Res. Inst.				
Alma Mater	3	1	1	5
Other	7	10	2	19
				24

TABLE II (Contd)

DISTRIBUTION OF GRADUATES SCHOOL B

	FIRST 10	INTER 18	LAST 5	TOTAL
Other Industry				
Gen. Admin.		3	-	3
Production	3	-	-	3
R and D	2	9	-	17
T.S. and Sales	2	4	2	8
				31
Other				
Bus. & Government	4	1	3	8
Retired	1	-	-	1
Unknown	5	1	-	6
Deceased	4	3	-	7
				22

EXHIBIT II

"THE PHD IN INDUSTRY"

I shall confine my remarks to the role of the PhD in the paper industry only.

The PhD has but one role to play in the paper industry, that of a researcher. All other facets of an industrial paper group are either a waste of talent or a misplacement of the PhD. In production, for example, the PhD generally does not have the basic tools necessary for the job. A PhD's method of evaluating the problems in production are contrary to the type of "action man" required. In all restrictions or limitations which I place on the PhD there is one root cause: the post-graduate training. In my experience the very narrow and specialized scope of the PhD's thesis program undoes a broad spectrum of outlook the science student had as an undergraduate. Undoubtedly, this is a general rather than absolute rule, but the majority of PhD's are, in fact, equipped only for research.

In what areas of research is the PhD best suited? Fundamental, development or applied? And what of his role as the director or head in these various avenues of research?

In Canada and the U.S., most fundamental studies applicable to the paper industry are conducted in central institutes or universities. Industrial research groups are generally small and depend upon the institutes for the fundamental work. On these fundamental studies depends the progress of the industry, to understand why and how certain phenomena occur and, through understanding, how they can be improved. It is the role of the PhD to find these "whys" and "hows", a role he has been well trained to fulfill. In fundamental research in universities and institutes the PhD finds his true vocation and at all levels of leadership and direction.

In the development stages, the PhD fulfills a function of guiding the progress of his basic work. Here we are involved with bringing the original concepts along, model studies, if you like. At this juncture the PhD begins to fade because, I believe, they are "second-best" at projecting or applying basic work. Again this is due to their training. Since the eventual aim of all fundamental work is practical application, the most important item is application. It is also, for reasons mentioned, why PhD's generally make poor directors or heads of a group involved in all phases of research or the latter stages of same.

Today PhD's are being thrusted into the top positions of research groups almost before they have encountered "one round of fire" and certainly long before they have "won their spurs". Generally, the PhD finds himself assuming an increasingly growing role as an administrator, which is a complete waste of talent, or as a director trying to organize all phases of a research group and having a devil of a time in the applications of research projects.

PhD's - stick with your test tubes!

EXHIBIT III

Dear Jasper:

I have your recent letter hre, but very little time to summon thoughts regarding PhD's and industry, as I leave in a couple of days for Europe. I hope to be there for up to two months, and travel from Egypt to England via VW. I have so much money sunk in the trip now it will be much cheaper to go than to chicken out.

By the way, I have not yet seen the research paper you mentioned earlier, in case it has been mailed.

I could better have told you about the industrialist in the PhD program than vice versa, since I have not yet had enough experience with the degree to see its affects. In that light, my Oxford and previous experience was a great help to me. It gave me the wisdom to make the shortcuts and siftings that we surmised it would, thus saving me much wasted time on academic and undergraduate folderol.

Also, the experience itself made me an expert in a field - paper - and that proved to be so attractive to my advisor, who consults for a paper company, that he let me slip through his fingers in two short years. He seemed to feel that, since I was already a proven expert in the field, there was little reason to hang onto me and make me prove it in the usual academic way. I mean, it usually takes three to five years for the degree. In fairness to him, though, maybe it was my political prowess, learned at your hands and others, that gave me an unfair advantage over less experienced students.

So much for the industrialist in the PhD program.

Looking back on the program, it seems to me to have been 90% thesis and 10% course work, discounting the nonsense that went with the program (two languages, and minor courses in management, which were optional). Thus, for me the 10% was truly educational, or as much so as it could be; but the 90% was no different than being in the paper mill working on some infernally sticky problem, sort of like the air hammer.

I expect to look back on the PhD program in a few years and see that:

1. the 10% course work was worthy of my time spent

2. the 90% project work could as well have been spent in any high quality lab - I mean, in any one with high capability people all around for mentation and consulting, e.g. Oxford was just below the line.

3. the nonsense work that went with the program was fairly broadening, but will vaporize quicker than the other work. It would be more broadening to a student without previous outside experience, no doubt - I was already fairly broad.

One other comment: you emphasize the PhD program, but at MIT, and I expect at a lot of other schools, the PhD program leans heavily on previous education of the same student at the same school.

1. having previous experience at the same school can cut time off your degree work, as you already know the rope, the dead professors and the good ones, etc.

2. I worked like hell the first semester I was at MIT, and put in two more semesters after that for my Master's degree. In that time, especially the first semester, I learned more than at any other period in the 3½ total years. Without it, the PhD program would have meant a lot more to me - or more likely have been impossible for me, in the state at which I left Oxford.

Thus, I would say my graduate education has been a lot more valuable than my PhD education, which has been minor.

I hope in your talk you will point out the differences between working hard, and learning at a high rate. Hack work, nonsense courses, figure drawing, walking or running to classes, satisfying stupid tenured professors - these can all be hard work. For post-graduate education to be appropriate for industrial work, it has to be education, not work; and I guess the psychologists' definition of learning would make the difference.

Finally, even though say you learn 10^n bits of information in your post-graduate education, I mean that 10% that I have called worthwhile, only a small fraction of it will be called into use on your first job. But this is the same in changing to any new occupation, I guess.

John E. Wilder

LIST OF REFERENCES

1. Mardon, J.
   The Organization and Direction of Industrial Research for Productive End Result
   Pulp and Paper Mag. of Canada 63; No. 8; 102-6, No. 9; 89-94

2. Collinson, H. A.
   Management for Research and Development
   Pitman 1964

3. Prior, P. H.
   Private Communications 1965

4. Firrell, J. P.
   Private Communications 1965

5. Anon
   Research in the British Paper Industry
   The Papermaker, December 1962

6. Editorial
   Product Engineering January 22, 1962

7. Scudder, R. B.
   Big Business and New Ideas
   TAPPI 47; 12; 39A-41A, December 1964

8. Hiscocks, E. S.
   Selection of Personnel for Research
   J. Royal Inst. Chem.; July 1964; 187-194

9. Symposium
   Better Utilization of Technical Manpower
   TAPPI 44; 9; 12A-42A; September 1961

10. Anon
    The Measures Being Taken to Further Improve the Selection and Training of Scientific Personnel
    Izvestiya, 18th May 1962, P. 1 and 3

11. Cotgrove, S. and Box, S.
    Scientists and Employers
    New Scientist; No. 390; 7 May 1964, p. 362-364

12. Kolmogorav, A.
    Science Demands Enthusiasm

13. Gregory, S. A.
    Creativity in Chemical Engineering Research
    Productivity in Research, London Inst. of Chem. Engrs. 1963

14. Sparks, W. J.
Invention: Vital Third Dimension of Science
Chemistry and Industry; April 25, 1964, p. 690-692

15. Editorial
An Attempt to Plan for Accidental Discoveries
New Scientist No. 361; p. 147; 17th Oct. 1963

16. Debye, P.
Density of Discovery
International Science and Technology; Sept. 1965; p. 55-60

17. Myers, S.
Attitude and Innovation
International Science and Technology; Oct. 1965; p. 91-96

18. Bass, L. W.
Historical Development of Industrial Research in the United States

19. Roffey, P.
The Organization of Research and Development
Chemistry and Industry April 28, 1962; p. 750-757

20. Holroyd, R.
Some Aspects of Research and Development in the Chemical Industry
Chemistry and Industry 1965; p.1051-1056

21. Hill, D. W.
The Role of Research in Product Development
Royal Inst. Chem., Sept. 1963, p. 296-300

22. Hill, D. W.
Research and Business
Manchester Statistical Society Report 1957

23. Fisk, J. B.
Strategy in Industrial Research
Research Management VI, 325-333 (Sept. 1963)

24. Caldwell, W. A.
Some Thoughts on Research and Development
J. Royal Inst. Chem., Oct. 1961, p. 354-359

25. Webb, G. A.
An Analysis of Research and Development in Relation to Evaluation
Memphis Meeting, American Inst. of Chemical Engineers, February 1964

26. Hanson, W. T.
Research in Industrial Organizations
Private Communication 1965

27. Collinson, H. A.
Management for Research and Development
Wilson Medal Paper British Inst. of Management 1962

28. Greenwalt, C. H.
Society of Chemical Industry Medal Address
Chemistry and Industry, Oct. 5, 1963, p. 1602-1605

29. Rogers, M. A. T.
Industrial Research
J. Royal Institute Chem., July 1964, p. 231-237

30. Wansborough Jones
Aspects of Research
Chemistry and Industry, July 4, 1964, p. 1200-1203

31. Kieffer, D. M.
Winds of Change in Industrial Research
Chemical and Engineering News, March 23, 1964, p. 88-109

32. Hunt, A. B.
Research and Development Objectives
The Engineering Journal, Nov. 1962, p. 52-56

33. Mitchell, J. W.
The Organization of Basic Research for the British Chemical Industry
Chemistry and Industry, May 29, 1965, 908-935

34. Kapitsa, P.
Theory Experiment, Practise
Ekanomicheskaya Gazeta 1962, 13, 10

35. Institution of Chemical Engineers (London)
Proceedings of the Symposium on Productivity in Research
1963

36. Quinn, J. B.
Long Range Planning of Industrial Research
Harvard Business Review, July/Aug. 1961

37. Quinn, J. B.
How to Evaluate Research Output
Pulp and Paper Mag. of Canada, Aug. 1961, p. 71-78

38. Drucker, P. F.
Managing for Business Effectiveness
Harvard Business Review, May/June 1963, p. 53-60

39. Quinn, J. B.
Fundamental Research Can be Planned
Harvard Business Review, p. 111-124

40. Hart, A.
Evaluation of Research and Development Projects
Chemistry and Industry, March 27, 1965, p. 549-554

41. Mardon, J.
Research Organization
Unpublished memo of June 1964

42. Taylor, J.
Restrictive Practises
Chemistry and Industry, Aug. 7, 1965, p. 1404-1406

43. Gould, J. R.
Ten Common Weaknesses in Engineering Reports
Chemical Engineering, Oct. 14, 1963, p. 210-214

44. Gutenmacher, L. L.
On the Question of Mechanical Handling of Information

45. Soman, K. R. and Krichevski
Soviet Abstract Journals and Relevant Problems of Organization

46. Aarnsen, M. H. and Nelson, R. C.
Breakdown in Communication
Instruments and Control System, Jan. 1963, p. 71-72

47. Glidden, H. K.
Reports, Technical Writing and Specifications
McGraw-Hill (1964)

48. Mardon, J.; Monahan, R. E.; Smith, K.H.; Manson, D.W.
Perforated Rolls, Design Structure and Use
Pulp and Paper Mag. of Canada 67; 11; 471-498 (Nov. 1966)

49. Mardon, J.; Monahan, R.E.; Carter, R.A.; Wilder, J.E.
The Dynamic Consolidation of Paper During Calendering
Consolidation of the Paper Web
Tech. Sec. BPBMA (1966) Vol. I, p. 576-627,
Edited by F. Bohan

50. Wahlstrom, P. B.
A Long Term Study of Water Removal and Moisture Distribution on a Newsprint Machine Press Section
1. Pulp and Paper Mag. of Canada 61; No. 8; T379-401 (Aug. 1960)
2. IBID 61; No. 9; T418-451 (Sept. 1960)

51. Mardon, J.
The Technical Audit Principles, Practice and Promulgation
Papper och Tra 45; No. 12; 689-702 (Dec. 1963)
46; No. 4; 305-314; (April 1964)
46; No. 6-7; 403-418 (June/July 1964)

52. Mardon, J.; Cripps, W.C.
The Training of Systems Engineers
Paper presented at meeting American Society of Training Manager, Boston, May 1967

53. Mardon, J.; Manson, D.W.; Wilder, J.E.; Monahan, R.E.
The Design of Manifold System for Paper Machine Headboxes Part I
Prepared paper Mag. of Canada 64; 2; T35-49 (Feb. 1963)

54. Mardon, J.; Manson, D.W.; Wilder, J.E.; Monahan, R.E.; Trufitt, A. and Brown, E.S.
The Design of Manifold Systems for paper machine Headboxes Part II Taper Flow Manifolds
TAPPI 46; 3; 172-187 (March 1963)

55. Mardon, J.; O'Blenes, G.; Wahlstrom, P.B.
The Hydrodynamics of Paper Machine Headbox Approach Piping
Pulp and Paper Mag. of Canada 59; 4; 139 (April 1958)

56. Mardon, J.; Truman, A.B.; O'Blenes, G.; Meadley, C.K.
A Consideration of the Factors Involved at the Open Draw of the Couch and Press of Fourdrinier Machines
Pulp and Paper Mag. of Canada 59; 10; 135-55 (Sept. 1958)

57. Mardon, J.; Monahan, R.E.; Mehaffey, W.H.; Dahlin, E.B.
A Practical and Experimental Investigation into the Stability and Control of Paper Machine Headboxes
Part I Papper och Tra 47; 1; 3-14; Jan. 1966
Part II Papper och Tra 47; 5; 301-309 May 1966

APPENDIX V

THE TRAINING OF NEW INTAKE ENGINEERS
FOR THE PULP AND PAPER INDUSTRY

This is a reprint of a paper by J. Mardon in "Pulp and Paper Magazine of Canada", December, 1965.

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TRAINING OF NEW INTAKE ENGINEERS FOR THE PULP AND PAPER INDUSTRY

J. Mardon

MacMillan Bloedel & Powell River Limited

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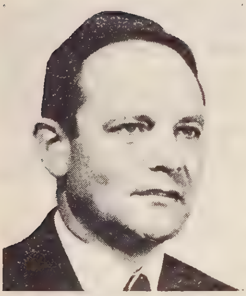

THE AUTHOR

ONE OF THE major pleasures of having lived a good technical life is to look back at all the good men with whom one has been associated, and to whose professional development a contribution may be justly claimed. The writer has been fortunate in this regard and because of the apparent success of his training methods for young engineers was asked to discuss in writing the methods which he has initiated and used.

While the writing of the article is predicated on the fact that the author has been of some help to a number of men starting in the industry, it must not be overlooked that he in turn owes much to many individuals, especially to W. F. E. Robinson and to J. P. Firrell. It must also be stressed that training is a two way process; the trainee learns much from the trainer because he originally knows considerably less; the trainer, however, learns from the trainee sometimes because of an observation, sometimes because he has to find the answer to a new and penetrating question, and always something about the process of training itself.

STEPS PRIOR TO THE TRAINING PROCESS

Training should ideally start with the selection of the man or men concerned. A genuine trainer who has both the talent and the will to train others can only deal with a limited number of men and he does not wish to waste his time on poor prospects.

The men who may be chosen may be divided into four categories:—

(a) Those straight from university.
(b) Men from another paper company with a few years' experience since leaving university.
(c) Men from another industry a few years after leaving university.
(d) Experienced men in the pulp and paper industry.

Over the past years the writer has dealt with men in all four of the above classifications. Exactly what one looks for in selecting men depends on in which category the man belongs; it is possible, however, to define some general points which should be considered.

Physical fitness. If he is to be trained intensively and to benefit from it a man should be fit. This is not to be taken as just a judgment from outward signs; one past associate who appeared quite frail was one of the best gymnasts in Canada. It should be remembered that physical fitness generally also carries with it mental alertness.

Drive. This usually goes along with physical fitness. It needs careful assessment; the noisy, bouncy fellows are often not those with most drive.

Ability to organize his own time. Men of the top class, and of the type desired, by the time they are being interviewed have almost invariably learnt how to organize their time so that none is frittered away—they are either working hard or playing hard. Ability to organize time and drive are interrelated. They can best be searched for by a series of questions designed to make the man being interviewed talk. This leads to the second law of interviewing.

Academic ability. While every attention should be paid to the man's academic performance, this is not necessarily the same as academic ability. For a man newly graduated the depth of understanding in the principal subject should be explored. Where any doubt exists telephone checks should be made with a suitable professor. I have frequently found high academic ability with mediocre academic record.

For a man with experience, the knowledge gained subsequent to graduation and the depth of understanding should be examined. For a man with more experience his published work should be discussed with special emphasis on the underlying principles.

Depending on what one is interviewing for, does the man have "devil". This is not necessarily identical with drive. By "devil" I mean a positive answer to the question. "If I hire this man and he trains on well, will he is several years have advanced to the point where he is going to cause me trouble by making me work hard to keep ahead of him?" If the answer is yes I always hire him.

Creativity is difficult to define. It has been discussed in Ref. (5) by the present author and has been referred to with varying degrees of accuracy by the various authors of Ref. (6). By creativity the present author understands the power of seeing a set of facts either as a total entity defining a problem or as indicating that a problem exists, continued into the power of conceiving an original and appropriate method or solution.

It is vital for a trainer to be able to distinguish be-

tween a man possessed of creative talent and the pedestrian individuals who can do a first rate job once someone with the creative touch has indicated how. The lack of creativity shows up most clearly in an uninspired research department or group, but it must be appreciated that this quality is of major importance in all endeavours. All the great generals, for example, have had creativity. Thus, when interviewing one should always probe to find out whether or not the candidate has this talent. If one can find a man of drive, devil and creativity, then one is indeed fortunate.

We, thus, end up with four types each of which may be classed either (a), (b), (c), or (d) as above from the standpoint of experience.

(a) First class and creative
(b) First class but without creativity
(c) Top second class
(d) Below top second class but acceptable

There should be no particular desire for any one disicipline—"have a mixed bag" is a good motto. Mechanical and Electrical Engineers, Chemical Engineers, Chemists, Physicists, Engineering Physicists, Mathematicians, and even Biologists will all make good Pulp Technologists.

Having sorted out the man in the interview and succeeded in selling him on your company and yourself (see rules of interviewing), you move to the training phase. This is interlinked with the interviewing because to attract good men you have to sell them on yourself. Men usually join a company because someone in it, rather than the company itself, has impressed them.

The training

General

The actual training must depend to a large extent on the classification of the man as summed up in the table.

Experience	a	b	c	d
2				
1				
3				
4				

Ability

In all categories there are two ironclad rules to be observed.

(i) Every training process is two way. The trainer can always learn something from the trainee. In the case of the new university graduate, he is likely to learn something about training, and in the case of the more experienced man, he will learn about the process or the control of the process.
(ii) The amount that the trainee learns is controlled by the amount of organization and planing that has gone into making out the program.
(iii) Even with the best planned program some work on the part of the immediate supervisor is necessary.
(iv) The immediate supervisor must be genuinely interested in people in general and the men whose training he is supervising in particular.

New graduates and men of some experience from other industry

These can essentially be dealt with together, the minor differences being pointed out as they come up. The basic principles here are that people want to be trained and they need personal supervision. My method has been to use "the tutorial system". By this I mean that each new graduate is given a tutor who is his immediate supervisor. This technique has been adopted as when young engineers join a company it is only possible for one man to keep track of them all if he is a full-time training manager with an adequate administrative staff. Even if a full-time training manager is on hand he is unlikely to possess the necessary technical background to provide the detailed supervision.

The necessary degree of enthusiasm and supervision are imparted by the immediate supervisor who is usually selected from the technical men who have been with the company between three and five years. As a general rule not more than two new men are allotted to any one of the supervisors all of whom are working members of the mill, administrative, or research staff of the company.

A detailed training program is then prepared for the trainee. Such a training program would contain the following sections:

(i) An introduction explaining the scope of the training and what the man was being trained for.
(ii) A job description, or job descriptions, of the job, or jobs, which the man would be suited for on completion of the training.
(iii) A list of books that the man should have access to or own.
At the present time (May 1965) the list would be as follows:
Modern Methods of Mechanical Pulp Manufacture, K. H. Klemm, Lockwood
Fourdrinier Papermaking, G. Gavelin, Lockwood
Paper and Paper Board Drying, G. Gavelin, Lockwood
Calendering and Supercalendering, Anon, Lockwood
Handbook of Pulp and Paper Technology, K. W. Britt, Reinhold
Papermaking, B.P.B.M.A.
Pulp and Paper Manufacture, Stephenson, McGraw-Hill
Pulp and Paper Mill Instrumentation, Cole & Todd, Lockwood
Paper Machine Crew Operators Manual, Mardon, Arklie, McInnes & Buser, Lockwood
A Laboratory Handbook of Pulp and Paper Manufacture, Grant, St. Martin's Press
CPPA or TAPPI Data Sheets and Standard Methods
Pulp and Paper Vol. 1, Pulping & Bleaching, Vol. 2 Chemistry & Chemical Technology, Vol. 3 Paper Testing & Converting, J. P. Casey, Interscience (1960)
(iv) A detailed layout of the five process training vehicles. The entire pulp and papermaking process has been divided into a number of booklets in each of which the relevant questions regarding that part of the process was asked. Answering those questions will demand of the trainee that he both investigate and understand the process.
The books are:
— Groundwood Mill Book
— Sulphite Mill Book*

* Prepared with the present author by M. O'Brien

— Kraft Mill Data Book**
— Bleach Plant Data Book**
— Paper Mill Inspection Procedure***

The details of these books have been published as Ref. (1) and are shortly to be republished in book form (3). There is, thus, no point in reproducing these in detail in the present article. Appendix II shows a typical section of the questions asked in the Paper Mill Inspection Procedure; the questions posed in the other training vehicles are similar.

(v) A reading list made up of selected papers published during the past ten years. The current reading list for papermaking suggested by the author is included as Appendix III.

(vi) A list of suitable correspondence courses in pulp and papermaking and in process instrumentation.

(vii) A progress guide which contains the various sections of the mill laid out in the manner indicated below:

Section of Mill	References (Books) (1)	(2)	(3)	Discussed	OK'd
Subsection detail				Page No.	Page No. Page No.

Part of the program guide for the paper mill as published in (1) (4) is shown as Appendix IV.

The purpose of this progress guide is to enable the immediate supervisor to orally examine the trainee; if the trainee shows adequate knowledge of the subject area of the mill, the immediate supervisor will tick and initial in the discussed column. At some subsequent date the overall supervisor will, if he is technically capable of doing so, examine the trainee and will initial the last column. If the overall supervisor is only an administrator, he will have someone with special competence in the particular area or process ask the questions and sign the OK'd column.

(viii) A timed training schedule.

The exact timing will depend on whether the man is being trained full-time or whether he has been allocated a normal job and is receiving his training on a part-time basis.

The timed schedule lays out the order of tackling the various assignments and the length of time allotted for each.

(ix) A description as to how to set about making a literature survey.

The literature in the pulp and paper field is reasonably extensive. It is, therefore, astonishing how many young men, thrown into practical operation with inadequate or faulty training, try to solve problems which have been solved by others years ago. A typical example is the pitch and/or sizing deposition problem. The author cannot count the numerous occasions when he has seen mill personnel trying to solve this problem in their own mills with the aid of suppliers without it ever occurring to them to read the literature.

The term "literature survey" is ill understood in our industry. By it is meant not only the preparation of a list of the most pertinent references, but also the reading of the papers listed, completion of the list by tracking down any pertinent papers from the references in the first set and then the writing of a critical appraisal of the state of knowledge regarding this particular subject. It is this critical appraisal which is the literature survey: a description of how this is done is contained in Refs. (1) and (3). Here it is pertinent to point out that a survey usually has to go through several editions before it is satisfactory, being rewritten after each careful critical and documented review by a competent reviewer. He may or may not be the trainee's immediate supervisor.

As an aid in discussing literature surveys and to illustrate what is required, the author has filed the successive stages of various literature surveys together with the critical comments made on the earlier stages.

(x) Two or three topics for a literature survey, one of which is to be selected by the trainee. The time for the literature survey is included in the trainee's timed training schedule.

(xi) A booklet giving the details of the papermaking examinations of the City and Guilds of London Institute. The trainee is encouraged to take these examinations when he and his supervisor feel that he is ready for them.

The present writer has conducted these examinations in North America for ten years under the auspices of the Provincial or State Education Departments, the most successful being 1964 when 17 candidates passed, two with distinction.

At the present time the examinations are at two levels:

Papermaking Practice suitable as a first examination for trainees and for machine crew.

Science and Technology of Papermaking—Intermediate level, suitable as an examination for trainees at the end of one year.

Final level, suitable as an examination for trainees after two years. The City and Guilds Publication should be consulted for administrative details. Old examination papers, essential for training can be obtained from the Institute.*

It might at this stage be noted that the Institute have an award under letters patent, City and Guilds of London Insignia Award, distinguished by the letters C.G.I.A. that may be attempted after eight full years in the industry and by those holding a first class certificate in the Science and Technology of Papermaking examination. This examination qualification is regarded as an "Industrial Ph.D.".

Men who have passed through a training program of the type now described should be encouraged in due course to try for the C.G.I.A. if qualified.

(xii) A section on the organization of projects in the field of technical pulp and papermaking. In this section stress is laid on the importance of an adequate literature survey and careful planning.

Reference is made to material on hand for

**Prepared by B. I. Howe
***Prepared with the present author by P. B. Wahlstrom

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which both the original detailed plan, and the final reports are available so that plan and execution can be compared. The plan's final reports and publications, Wahlstrom's and Delisle's press studies of various drying and ventilation studies, and of paper machine studies, were retained for this purpose.

(xiii) A list of knowledgeable personnel who are prepared to answer properly prepared questions in each area of the mill.

Crash program for those who have some knowledge but require training in methods of technical papermaking

Each of these programs must be specific and it appears as if such a program can best be illustrated by a specific example. One is accordingly included as Appendix VI. Usually it is easier to train two men simultaneously as they can work together and stimulate each other in the discussions they have after hours.

Training of senior and more experienced personnel

This is a specialized subject; each man must be considered individually and the only safe rule is that the reason for, and method of, the training must be fully discussed with the man concerned. Every effort should be made to take advantage of advanced courses and a list should be maintained of courses currently available that might conceivably be of interest.

It is in participating in the training of more senior personnel that the trainer gains as much, and sometimes more, than the trainee. The author's usual method of ensuring that the training of more senior personnel is not overlooked has been to ask the individuals in question to prepare a training and development outline. The timing on these would vary from approximately six months as in the example attached for Appendix VII to two years or more.

Discussion

By means of a program of the type outlined above, a man is provided with an objective, a detailed plan on which he can work with minimal supervision, a schedule timed according to circumstances, an enthusiastic supervisor, and knowledgeable discussion partners and examiners. Usually a keen spirit of competition develops between the various immediate supervisors, each striving to make his one or two trainees a genuine credit to him. The advantage of the method is that as a result of careful planning, the individual has in his possession a detailed set of instructions as to how to set about acquiring the knowledge that he needs in a manner which facilitates and indeed enforces rapid progress whilst demanding only an amount of supervision which can reasonably be made available.

In the forgoing description of the training methods adopted by the writer no distinction has been made between pulping and papermaking. In the ideal case there would be time to teach a man all the relevant information in both fields. It is almost invariably found, however, that there is insufficient time available to do this and it is, thus, advisable to bias the program for any one individual in the areas of pulping, papermaking, or instrumentation and control.

When the writer first formalized this system in 1955, he suggested that the industry should organize a post-graduate diploma in pulp and paper manufacture. It was envisaged that the diploma could be formulated along the following lines.

(a) The trainee completes a training program on the lines discussed above.

(b) Subsequent to this he sits for a Canadian organized examination approximately equivalent to, but somewhat more difficult than, the City and Guilds of London examination "Papermaking Practice".
It is suggested that this examination be in two parts, one for pulping and the second for papermaking. It should be possible to sit for either part singly or for both together. The examination would be required to certify that it was conducted in accordance with the regulations.

(c) Following the successful passing of the examination the candidate would write a thesis on a topic selected by the examining board from among several suggested by the candidate. There would be a time limit for submission of the completed thesis.

(d) When after question by correspondence the thesis was accepted, the candidate would have an oral examination. On successful completion of the oral examination a diploma would be awarded.

(e) Alternatively, since it might be considered that the work of organizing the examination would be too great it might be considered that a system could be constructed whereby the candidate would be allowed to submit the thesis on satisfactory recommendation by the mill manager or equivalent.

The provision of a diploma in Applied Pulp and Paper Technology is suggested as being important because people like to have something to show for the work they have done.

REFERENCES

(1) *Training engineers and technicians*
The Papermaker, London
Part I, General Principles and the Paper Mill Book, 45; 48; 50 (Jan. 1961)
Part II, Papermaking, 50—52; 70; 71 (Feb. 1961)
Part III, Groundwood Mill Book, 38—40 (April 1961)
Part IV, Sulphite Mill Book, 62—64 (May 1961)
Part V, Screening and Kraft Mill Book, 47; 48; 62; 63 (June 1961)
Part VI, Bleach Plant Data, 69; 70; 72 (July 1961)
Part VII, Detailed Training Programs, 45—48; 68 (Nov 1961); 49; 50, 79 (Dec. 1961); 62; 76; 77 (Jan. 1962); 75; 76 (March 1962); 73 (April 1962)
Part VIII, The use of a literature survey, 75; 80 (April 1962); 66—68; 70; 71 (May 1961); 68; 70; 72 (June 1962); 63; 64 (July 1962); 48; 52 (Aug. 1962)
Conclusion, 69; 72 (Aug 1962)

(2) *The Training of paper machine crews and of papermaking supervisors*
The Papermaker London, International No. 1962, 78—80; 102 *Paper Trade Journal,* 146 No. 20; 47—49 (May 14, 1962)

(3) *Training in the Pulp and Paper Industry,* Mardon, J., Howe, B. I. and Hardman, H.
In the Press, National Business Publications

(4) Mardon, J., Arklie, R. G., McInnes, A. and Buser, R. Paper Machine Crew Operating Manual, Lockwood

(5) Mardon, J., The Organization and Direction of Industrial Research for Productive End Result, Pulp Paper Mag. Can. 63:8; 102—106:9; 89—94:10; 83—88

(6) The Institution of Chemical Engineers, Productivity in Research, Symposium Proceedings 1963.

APPENDIX I—THE AUTHOR'S RULES FOR INTERVIEWING

(1) Have a clear mandate before you begin.
 (a) How many
 (b) What for
 (c) How much

(2) Put the man at ease by suitable remarks and ensuring that the place of interview is comfortable and suited for its purpose.

(3) Convey in your opening remarks that you are *genuinely* interested in him. Have the personal and professional data on the man in front of you laid out in a manner which enables you to refresh your memory without being too obvious.

(4) Phrase your remarks in a manner that makes the man being interviewed do the talking. While you talk he is learning about you; at the early stage in the interview the object is that you should learn *about him.*

(5) Decide whether you want to hire this man or note; this may be too early for a final decision so if in doubt delay the decision and carry on with an abbreviated version of (6) below.

(6) Sell him on the company. Of course have all the usual material on hand—annual reports, appropriate speeches by president or board chairman, organizational structure, etc.
Have a detailed account of the careers of three or four suitable men who have joined the company at various time intervals. Show the thought behind the company moving them around.
Without promising anything that cannot be backed up, have a clear indication available of the channels of progress available to this particular man. Have an appropriate job description to hand.
Have typical training programs for those hired in past years to show the depth of thought that has gone into preparing them.

(7) Sell him on yourself. Generally, *really good men* go to work for a man rather than a company. Every man must have his own method for this. In principle, you should show what you yourself have achieved and how you have developed others.

(8) Never get involved in a struggle for a man's soul with his wife. Interview the wife also and if you have doubts, don't hire the man.

APPENDIX II—SET OF QUESTIONS FROM PAPER MILL INSPECTION BOOK

The Paper Mill Inspection Book is believed to be of considerable interest to the industry. Several companies have already copied it and are using this idea. It is, therefore, reproduced in abbreviated form below. It has been used in the training of young engineers in two ways:

(a) After a reasonable period of training the trainee is given the book and is asked to explain in writing on each page exactly why anyone should be interested in the answers to the questions on that page.

(b) The trainee is sent off for two days to some local friendly mill to fill in the book for one or more of their machines. The completed book is then marked by his supervisor, usually in concert with a friend from the mill concerned.

Abbreviated text of the book

(Nos. on the left-hand side refer to page nos. in the actual book).

General information section

1. Grade of paper, machine speed, production.

Basis Weight — No. — Name of Grade — Average Speed fpm — Average Prod. lb/in. Hr. — Trim in. — Average Prod. lb/day — Limiting Factors

2. Properties

Basis Weight — No. — Name of Grade — Caliper — Moisture — Mullen — Tensile len. cross — Stretch MD, CD — Tear — Porosity — Freeness — No. — Smoothness — Stiffness — Dirt Count — Size — Printability — Brightness

5. End Use.
6. Converting Operations to come—if any.
7. General Specifications of the paper.
8. Specifications of the paper, specific for end use (printability, stability).

No. — Grade — Critical quality (if measurable, give limits) — Particulars in machine operation for specific quality

9. Furnish (and proportions if mixed).
10. Additions (sizes, dyes, fillers, etc.).
11. Slime control (chemical, how and when added).
12. Foam killers and dispersing agents.

Stock Preparation System Section

13. (1) Disintegration system (also control of desired proportions of different stocks, layout from screen chests to basis weight control).
14. (2) System of broke addition.
15. (3) System for preparation and addition additives (alum, size, filler, dyes, starch wax).
16. Control of consistency.
17. Chest system.
18. Type of circulation in chests. Horsepower for circulation.
20. Number, type and arrangement of refiners, power consumption of refiners and consistency.
22. (10) Power consumption of grades.
 (Throughput of refiners).

Basis Weight — Grade — No. — Refiners Consumption Av. Power — Production — Freeness — Power Consumption KWh/ton

23. Type and life of refiner filling; appearance of worn out filling. Reason for change of filling.
24. pH at refining and how controlled.
26. Control of refining and instrumentation.

Screening System

27. Methods of screening (flow system).
28. Number, types of screen, dimensions of perforations or slots (when installed and when worn out).
29. Percentage of rejects.
30. Screen capacities, consistency of feed, power to screens.
33. Layout of flow system from basis weight control to headbox.

APPENDIX III—READING LIST

Prior to papermachine

1. Mardon, J.; Wahlstrom, P. B. and O'Blenes, G., The Hydrodynamics of Paper Machine Headbox Approach Piping. *Pulp Paper Mag. Can.*, 59:4:139 (April, 1958)
2. Burkhard, G. and Wrist, P., The Evaluation of Paper Machine Stock Systems by Basis Weight Analysis, *Pulp Paper Mag. Can.*, 55: No. 13 188—200 (Dec. 1954)
3. Baines, W. D., The Influence of a Simple Surge Tank on Pressure Oscillations in a Piping System, *Pulp Paper Mag. of Can.*, 59, No. C 177—183 (1958)
4. Bennett, H. W., The Flow Characteristics of Distributor Rolls and Perforated Plates, *Tappi* 40: No. 12, 978—83 (Dec. 1957)

Papermachine construction and operation—fourdrinier

1. Tappi publication on Process Control, Hershey, P. H., Fourdrinier Process Control Results of Survey Questionnaire, *Tappi* 45:7 139A—143A (July 1962)
2. Cole, E. J., How does your in-process wet end control stand up to the competition, *Paper Trade J.* 147:17: 40:42 (April 29, 1963).
3. Mardon, J. The effects of Slice Flow and Flow on the Wire on Newsprint Paper Formation and Properties, *Paperi ja Puu* 43:5 327—342, 43:6 383—391; 393—396 43:7 419—430—432—434.
4. Murphy, A. R. and Webster, G. H. Investigation of Wet End Flow Problems, *Pulp Paper Mag. Can.* 50:3:275
5. Mardon, J., The Design of Paper Machine Headboxes for Optimum Wire Flow and Formation, Presented Appita Conference, Sydney, (1964).
6. Mardon, J. and Truman, A. B., The Wake Effect, Ridge Formation, and Spout Development on the Wire of the Fourdrinier Machine, *Pappier och Tra* No. 9:391 (1959)
7. Brewden, H. A. and Locking, B., New Developments in Paper Machine Headbox Design and Equipment, *Paper Trade J.* 144:31:36—42, 144:32:24—29, 144: 33:38—44
8. Mardon, J., O'Blenes, G. and Ryan, J. A., Hydraulic Measurements in Paper Machine Headbox Design and Operation, *Svensk Papperstidn.* 59, No. 12 429—40
9. Nelson, H. C., Paper Machine Inlet Performance with Relation to the Fourdrinier Wire, *Tappi* 43, No. 4, 330—342
10. Cole, E. J., How the Sheet is Laid on the Wire, *Paper Trade J.*, Dec. 8, 1958
11. Alston, M. P., Goodhew, I. E. and Chapman, I., A Study of Formation on the Fourdrinier Wire, *Proc. Tech Sect.* BPBMA 36, No. 3:535—59 (Dec. 1959).
12. Muller-Rid, W. and Pausch, G., Studies on the Slice of a Newsprint Machine, *Wochbl Papierfabrik*:1959 87 11/12 478
13. Cole, E. J., Random Thoughts on Wiremarking, *Paper Trade J.* (Nov. 24, 1958).
14. Finger, E. R. and Majewski, Z. J., Sheet Formation on the Fourdrinier Machine, *Tappi* Vol. 37. No. 5: 216 (May 1964)
15. Muller-Red, W. and Pausch, G., Defective Web Formation on the Wire of High Speed Paper Machines, *Zellstoff and Papier* 1957, No. 10, 307.
16. Culver, R. and Mardon, J., Free Surface Flow on the Fourdrinier Wire, Journal of Australian Pulp and Paper Industry, Tech. Assn. Vol. 13:1:130 (1959).
17. Shapiro, G. S., Experience Gained in the Use of a New Type of Wire, *Bumazh. Prom.* 1959. 34. (6). 21
18. Baines, W. D., Nicholl, C. I. H., Cook, R. and Mardon, J. The Taper Flow Headboxes—A New Design Concept, *Pulp Paper Mag. Can.*, 57, No. 11:B9—48 (Oct. 1956)
19. Yih, C. S. and Spengos, A. C., Free Surface Instability, *Tappi* 42:5:398 (May 1959)
20. Van Der Meer, W., Hydraulics of Flow, Box and Slice, *Pulp Paper Mag. Can.*, 55, No. 13:103—9 (Dec. 1954)
21. Underhay, G. F., Drainage Effects and Two Sidedness, *Tappi* 37, No. 11:547—53
22. Rogers, G. A., Wet End Modifications for Improved Quality and Higher Speeds, *Paper Trade J.*, (March 26, 1962) P. 40
23. Doane, F. P., Key to More Profits—Remove Water at Wet End, *Paper Trade J.*, P. 35 (March 26, 1962) P. 35

Press part

1. Wahlstrom, P. B., A Long Term Study of Moisture Removal and Moisture Distribution on a Newsprint Machine Press Section, *Pulp Paper Mag. Can.*, Vol. 61, No. 8, T379—T401, No. 9, T4 18—451
2. Chinn, G. P., The Practical Application of Press Testing for Improved Paper Machine Performance. *Pulp Paper Mag. Can.*, Vol. 61, No. 5, T289—T293
3. Howe, B. I., Factors Affecting Pressing Efficiency on the High Speed Newsprint Suction Press, *Pulp Paper Mag. Can.*, 63:11:T515—T543

Drying

1. Chalmers, G. J., Performance testing the dryer section of a paper machine, *Pulp Paper Mag. Can.*, 55 No. 3, pp. 236—43, 273 (Convention issue, 1954)
2. Nuki, R. P., Paper Drying and Steam Circulation, Proc. Tech. Sect., Brit. Paper and Board Makers' Assoc., 35, No 1, 47—57; discussion 58—61, (Feb. 1954); *World's Paper Trade Rev.* 141, No. 16, pp. 1269—70, 1272, 1274, 1279 (April 22, 1954)
3. Snider, E. H., Newsprint Drying Questionnaire Summary, *Pulp Paper Mag. Can.*, pp. 254—61 (Convention issue, 1957) BIPC 27:962
4. Soininen, Mauri, Paper Drying Theory, *Paper Trade J.*, 142; No. 19, pp. 36—40 (May 12, 1958) BIPC 28:1613
5. Malkin, B. A., The Behaviour of Condensate in Paper Machine Dryers, (from the Dominion Engineer, March, 1946, Montreal, Quebec)
6. Montgomery, A. E., Heat Transfer Calculations for Paper Machines, *Tech. Assoc. Paper*, 29, No. 6, pp. 525—528 (June 1946)
7. Ban, S. T. and Tapio Ulmanans, Heat Transfer in Hot-Surface Drying of Paper, *Tappi* 41, No. 4, pp. 185—9 (April, 1958)
8. Montgomery, A. E., Variation of Drying Rates of Individual Dryers Through the Dryer Section, *Tappi* 37, No. 1 (Jan. 1954)
9. Preston, Thomas H., and Douphines, T. M., Some Factors Affecting Drying in Paper Machines, *Pulp Paper Mag. Can.* (April 1957)
10. Dreshfield, Arthur C., and Hane, S. T., The Drying of Paper, *Tappi* 39, No. (July, 1956)
11. Montgomery, A. E., *Tappi* 33, No. 5, pp. 64A (May 1950)
12. Fishwick, H. P., Design Considerations Affecting Dryer Drainage Systems, *Paper Mill News*, Oct. 5, 1957, Page 62, 68, 72, 99
13. Hanlon, R. T., The Causes and Prevention of Corrosion in Condensate Systems in Pulp and Paper Mills, *Pulp Paper Mag. Can.*, T239—T247, April 1961
14. Rase, E., Experiences in the Use of all Synthetic Dryer Felts, *Tappi* (Oct. 1959)
15. MacDonald, C. E., Wet End Ventilation of High

Speed Newsprint Machines, *Pulp Paper Mag. Can.* 52, No. 3, 156—158

16. LUKIONOVICH, S., Moisture Control with Closed Hoods, *Pulp Paper Mag. Can.*, 54, No. 10, 126 (Sept. 1953)
17. JORDAN, J. C., Paper Mill Ventilation with Closed Hoods at Iroquois Falls, *Pulp Paper Mag. Can.*, 54, No. 3 253
18. DAANE, ROBERT A., An Experimental Study of Some Dryer Drainage Siphons, *Tappi* 42, No. 3, pp. 208—18 (March, 1959) BIPC 29:1638
19. DAY, G. D., Some Characteristics of Dryer Drainage Devices, *Pulp Paper Mag. Can.* 59, No. 1:109—13 (Jan. 1958) BIPC 28:944
20. LONIGAN, JOHN J., The Ideal Dryer System, Australian Pulp & Paper Ind. Tech. Assoc. Proc. 5, pp. 26—43, discussion: 4—8 (1951) BIPC 22:833
21. SMITH, C. C., Steam and Condensate Systems for Fourdrinier and M. G. machines *Proc. Tech. Sect.*, Brit. Paper Board Makers Assoc. 36, No. 1:103—18; Discussion 119—27 (Feb. 1955) *World's Paper Trade Rev.* 144, No. 2, 121—2, 124, 126, 128, 130, 136, 139—40, 142 (July 14, 1955) BIPC 25:878
22. WHITE, ROBERT E., Residual Condensate Behaviour and Siphoning in Paper Dryers, *Tappi* 39, No. 4: 228—33 (April 1956) BIPC 26:736 *Appl. Chem.* (London) 6, No. 10:11—336 (Oct. 1956)
23. WHITE, ROBERT E. and HIGGINS, THOMAS, W., Effect of Fluid Properties on Condensate Behaviour, *Tappi* 41, No. 2:71—6 (Feb. 1958) BIPC 28:1099:C. A. 52: 11419
24. PATERSON, H. A., The Cowie Scraper, *Pulp Paper Mag. Can.* 51, No. 11:96—100 (Oct. 1950), BIPC 21:244
25. MCALEAR, J. M., A New Paper Machine Control System, *Tappi* 37, No. 3:121 (March 1954)
26. MARDON, J., O'BRIEN, G. A., and WAHLSTROM, B., Examples of the Use of Heat and Material Balances in the Study of the Drying of Paper and Board, *Norsk Skog Industri* 16; 11; 504—520 (November 1962)
27. O'BRIEN, G., DEMPSEY, J. E., MARSHALL, H., URBAS, J. C., MARDON, J., and WAHLSTROM, B. Examples of the Use of Heat and Material Balances in the Study of the Drying of Pulp Paper and Board Part II Paper Machines, *Norsk Skog Industri* 17; 4; 136—50 (April 1963)
28. CAMPBELL, D., MARSHALL, H., URBAS, J. C., SARLER, C. H., MARDON, J. and WAHLSTROM, B., Examples of the Use of Heat and Material Balances in the Study of the Drying of Pulp Paper and Board. Part III Drying and Ventilating Survey of A Board Machine, *Norsk Skog Industri* 17; 10; 395—406 (October 1963)
29. WAHLSTROM, P. B. and LARSSON, K. O., Factors Determining Condensate Removal, *Pulp Paper Mag. Can.*, 65; 5; T203
30. DAANE, R. A., An Analysis of Cross Machine Variations in Conventional Paper Drying, *Pulp Paper Mag. Can.*, 65; 5; T211
31. JEPSON, M. D., The Yankee Cylinder—High Velocity Hood Combination, *Pulp Paper Mag. Can.*, 65; 5; T219
32. GARDNER, T. A., Minimum Pressure Differentials Required for Dryer Drainage, *Pulp Paper Mag. Can.*, 65; 4; T188
33. BLATCHEY, C. G. and STRATTEN, H. J., The Performance of Thermo Compressors as Related to Paper Machine Dryer Drainage Systems, *Pulp Paper Mag. Can.*, 65; 7; 301
34. URBAS, J. C., Closed Hoods and Internal Air Behaviour, *Pulp Paper Mag. Can.*, 65; 7; 307
35. CHURCH, F., Moisture and Substance Control on the Paper Machine, *Pulp Paper Mag. Can.*, 66; 1; T3
36. LAURIN, M. I., Control of the Final Moisture Content of the Paper Web, *Pulp Paper Mag. Can.*, 66; 1; T11
37. Drying Felts—Madelin Hot Air Systems, *Tappi* 47; 9; 175A
38. Dryer Cylinder Uniformity, *Tappi* 46; 9; 531
39. Drying, *Tappi* 45; 9; 224A

Calendering

1. BLANCHARD, R. L., MARDON, J., MONAHAN, R. E., QUINT, R. J. and WILDER, J. E., The Change of Paper Properties Through Machine Calender Stacks Pt. 1, *Pulp Paper Mag. Can.*, 64: No. C:119 T132 (Convention issue 1963)
2. COOPER, E. W., Calender Operation, *Appita* Vol. 7 (1953) 24—53
3. HOWE, B. E. and LAMBERT, J. W., An Analysis of the Theory and Operation of High Speed Steel Roll Calender Stacks, *Pulp Paper Mag. Can.*, Vol. 62, No. C, T139 (Conv. issue 1961)
4. Calender Rolls—Dynamics of Heat Flow, *Tappi*, 47; 3; 145A
5. Calenders Crown Compensation by Swimming Roll, *Tappi;* 47; 8; 141A
6. Calender—Nip Relieving a Paper Machine, *Tappi;* 47; 8; 137A
7. Calender Crown Compensation by Precision Control, *Tappi;* 46; 6; 193A

General

1. MARDON, J. and MARDON, D., The Techniques and Utility of Lost Time Analysis—to be published
2. GAUDET, E. J., Better Control of Down Time Costs, *Paper Trade J.*, 26—28, Oct. 22nd. 1962
3. HOWE, B. I., *Pulp Paper Mag. Can.*, 63; No. 4: 78—82, No. 5:86—88, No. 6:89—213—214 (April, May, June 1962)
4. FORSYTHE, D. D., A Computer for Analyzing the Basis Weight Variation in Paper, *Pulp Paper Mag. Can.*, 54; 3; 275
5. O'BRIEN, M. J. and others, A Literature Survey of the Relationships between Newsprint Quality and Printability, Monogram to be Published Shortly
6. BERTHOLD, R., Contactless Area-Weight Measurements of Running Paper Web, *Zellstoff u Papier* 8. No. 5, 170—177
7. BRUNTON, D. C., The Betameter, *Pulp Paper Mag. Can.*, 54. No. 3. 220—4 (Convention Issue 1953)
8. FIEBIGBR, H., Measurement without Actual Contact of the Basis Weight of the Moving Paper by Beta Rays, *Wochl Papier Fabrik* 82. No. 11:452, 454—6, 458—9, No. B 45A
9. PANKRATOV, V. I. and PRICIPKO, I. T., Non Contact Automatice Beta Weight Meter, *Bumazh. Prom.* 33, No. 7, 11—14
10. MARDON, J., GAVELIN, G. and LOGAN, K. C., The Effects of Some Machine Characteristics on Paper Uniformity, *Pulp Paper Mag. Can.*, 56; 3; 275
11. EKWALL, A., Basis Weight Meter for Paper, *Norsk. Skog. Industri* 12, No. 1, 14—17
12. CUNNINGHAM, T. M., Betameter Chart and Plastic Ruler Method as an Aid to Basis Weight Control, *Tappi* 42, No. 7; 128A—9A
13. CHARTRAN, J. Y., Automatic Control with Betameter, *Pulp Paper Mag. Can.*, 59:5, 108—11
14. CLARK, J. L., Use of the Beta-Gauge in a Paper Mill, *Tappi* 40, No. 8. 175A—7A
15. FIEBIGER, H. and BOXCH, J., Basis Weight Regulation of Paper with the Aid of Beta-Rays, *Wochl. Papier.* Fabrik. 83, No. 7, 271—4, No. 8, 317—20, No. 10, 393

16. Hansson, K. I., Basis Weight Measurements with Beta-Rays III. Basis Weight Determination with the Beta Komparator, *Svensk. Papperstidn.* 56, No. 15, 590—7

17. Cuffey, W. H., Some Factors Involved in Basis Weight Uniformity, *Tappi* 40:6:190A

18. Smith, B. W., Scanning Basis Weight and Moisture Gauge Systems on Paper Machines, *Tappi* 43:3:226

19. Lee, C. A. and Johnson, C. R. G., U.S. Patent 2, 881, 674

20. Staege, S. A., Can. patent 598714 (original Filing November 16, 1956)

21. Mardon, J. and Wahlstrom, P. B., Lecture at the University of Darmstadt, June 9, 1959, *Svensk Papperstidn.* 63:No. 20; 716—728

22. Logan, K. C., Mardon, J., Easson, A., Petersons, R. and Sampson, G., The Use of High Speed Cinematography in Certain Aspects of Paper Making, BPB MA Proc. Tech. Section, 37, No. 3, 341—52 (Dec. 1956).

23. Mardon, J. and Petersons, R., APP Demonstration Film. 8.D. Shown at: Winter Meeting CPPA Jan. 1956, BPBMA Conference, Blackpool, 1956 Tappi Fluid Mechanics Committee Meeting, Feb. 1957
APP Demonstration Film 18.D. Fluid Mechanics Committee *Tappi* Feb. 1960. Annual Meeting Finnish Paper Engineers, Helsinki, April 1959
APP Demonstration Film 26, D. 27 D. not publicly shown (1960)

24. Alston, M. P., Goodhew, I. E. and Chapman, J., A Study of Fibre Distribution in Relation to Machine Operation, *Pulp Paper Mag. Can.*, 57, No. 6, 125—8

25. Burkhard, G., Wrist, P. E. and Mance, G. R., A Formation Tester which Graphically Records Paper Structure, *Pulp Paper Mag. Can.*, T319 (June 1960)

26. Williams, D. J., A Formation Recorder for Paper Machines, Proc. Tech. Sect.. of Australian Pulp and Paper Industry 9, 209—219

27. Gavelin, G., Some Effects of Gases on Properties of Fibre Suspensions, *Pulp Paper Mag. Can.*, 55, No. 3, 191—200 (Conv. Issue 1954)

28. Lamb, C. A., Verification Problems in Papermaking, *Tappi* Vol. 43, No. 4, 151A (April 1960)

29. Atack, D. and Forgacs, O. L., The Evaluation of Groundwood for Newsprint Production, *Pulp Paper Mag. Can.* 62, No. 3, T187

30. Brecht, W. and Wesp, A., The Measurements of Uniformity of Formation of Paper, *Das Papier* 1952. 6. 17/18. 359. 19/20 411

31. Billing, O., Gavelin, G. and Johnsson, B., P.C.L.'s Recording Caliper Meter, *Svensk Papperstidn.* 62, No. 23, 888 (Dec. 15, 1959)

32. Hart, J. A. and Galley, W., The Aquatel, A New Moisture Meter for Paper, *Pulp Paper Mag. Can.*, 58 No. 3195—200 (Conv. Issue 1957)

33. Erince, R. W., Some Factors Affecting the Printability of Newsprint, *Tappi* 42, No. 5 (May, 1959)

34. Gavelin, G., The Compressibility of Newsprint, *Svensk Papperstidn.* 52:17:413

35. Ant-Wuorinen, O., The Pressure Elasticity of Newsprint and its Components, Papper och Tra 20, No. 15A 73—4, 76—8, 80—2, 84: (August 15, 1938), No. 15, 569—573 (August 15, 1938)

36. Coupe, & Smith, A Commentary on the Printability of Newsprint, Proceedings of the PATTRA Newspaper and Rotary Letterpress Conference, Part II, pp. 193

37. Delisle, J. C. and Cooper, S. R., Fast Roundup on Important New Papermaking Developments, *Paper Trade Journal*, P. 41 (June 3, 1963)

38. Mardon, J., Gavelin, G., and Logan, K. C., *Pulp Paper Mag. Can.*, 56:3, 275

39. Mardon, J., O'Blenes, G., Ryan, J. A., and Samson, G., *Svensk Papperstidn.*, 59; 12, 429

40. Logan, K., Mardon, J., Easson, A., Peterson, R., and Samson, G. Proc. Tech. Section BPBMA 37; 3, 341

41. Mason, S. G., Robinson, A. A., Allan, G. A. and Walter, C. W. E., *Pulp Paper Mag. Can.*, 55; 9, 168

42. Sergeant, S. V., *Proc. Tech. Sec.* BPBMA, 33; 1, 49

43. Mardon, J., O'Blenes, G. and Wahlstrom, P. B., *Pulp Paper Mag. Can.*, 59; 4, 139

44. Mardon, J. and O'Blenes, G., *Papper och Tra*, 39; 4a, 185

45. Baines, W. D., Nicholl, A. H., Cook, R. C. and Mardon, J., *Pulp Paper Mag. Can.*, 57; 11, 56

46. Baines, W. D., NRC report MH 65 National Research Council of Canada, Ottawa.

Training and Organization

1. Mardon, J. and Howe, B. I., Training Engineers and Technicians Pt. 1, *The Papermaker* (London) Jan. 1961, pp. 46, 48, 50

2. Arklie, R. G., McInnes, A. and Mardon, J., The training of Paper & Board Mill Operators, *Pulp Paper Mag. Can.*, 58; 3:308 (Convention Issue 1957)

3. Mardon, J., Training of Paper Machine Crews and Papermaking Supervisors 146;No. 20 47—49, *Paper Trade J.* (May 14, 1962)

4. Mardon, J., Training Engineers and Technicians, Parts I and II, *The Paper Maker*, London, Jan. 1961, p. 45, 48, 50, Feb. 1961, P. 50—52—70 and 71, April 1962, p. 74—75 and 80

5. Mardon, J., The Company Training Manager in the Organization and Direction of Industrial Research for Productive End Results, *Pulp Paper Mag. Can.*, Vol. 63, No. 8, pp. 102—106 (August 1962), No. 10, pp. 83—88 (October 1962)

Fabrics

1. Petrich, Experience with Forming Fabrics at Howard Paper Mills, *Paper Trade Journal*, P. 34 (February 3, 1964)

2. Dyer, H. and Evans, J. C. W., From Breast Roll to Sweat Dryer Plaster Fabrics Herald New Technology, *Paper Trade Journal*, P. 30 (January 7, 1963), Formex Fabric Applications, *Tappi* 45; 1; 186A

3. Christiansen, A. P. and Newsome, P. J., Use of Synthetic Wires on a Fine Paper Machine, *Pulp Paper Mag. Can.*, 65; 8; p. 83

Foils

1. Finley, E. F. and Thorpe, B. A., Quantitative Evaluation of Water Removed by Hydrafoils versus Table Rolls, *Paper Trade J.*, p. 28 (October 26, 1964)

2. Dyer, H., Foils and Fabrics mean more and better paper for Domtar, *Paper Trade J.*, p. 38 (April 15, 1963)
Hydrofoils versus Table Rolls, *Tappi* 47; 10; 192A

Fabric Press

1. Tenfolt, E. and Wahlstrom, P. B., First report on Scandinavian Experience with Fabric Presses, *Paper Trade J.*, P. 38 (February 24, 1964), Vented Nip Press, *Tappi*, 47; 8; 493, Fabric Press, *Tappi*, 46; 9; 221A

Flat boxes and rotabelts, etc.

1. De la Touche, B., A report from France on Rolvac Suction Units, *Paper Trade J.*, P. 45, (July 13, 1964), Flo Vac, Rolless Application on fourdrinier machine, *Tappi;* 45; 10; 830

APPENDIX IV — PORTION OF PROGRAM GUIDE FOR PAPER MILL

Section of Paper Mill or Machine	Type of Equipment	Paper Machine Operators Manual	Calkin	Stephenson Volume 1	Stephenson Volume 2	Stephenson Volume 3	Stephenson Volume 4	Papermaking Practice	Fourdrinier Wet Ends	Fourdrinier Papermaking	Discuss O.K.'d
Stock Preparation		35									
	Hollander Beater		272		113						
					200	80					
	Hydrapulpers		277		117					25	
	Jones Pulpmaster				123						
	Consistency Regulators	1, 6, 35, 72				12					
	Trimbey					14					
	Dezurik					15					
	Brammer					17					
	Metering Tanks										
	Trimbey Metering & Proportioning System	35				24					
	Fischer & Porter Flowrater Proportioning Unit					26					
	Savealls:	13								28, 32	
	Inclined Wire		376			34					
	CylinderType					34					
	Bird					36					
	Wace Filter					38					
	Oliver			766							
	Stock Chests							83			
	Beating							107			
	Sizing							112			
Paper Machine		38							5		
Screens	Bird	3, 38		739		71				15	
	Selectifier	39	313			75				16	
	Flat	3, 40	311	746		63					
	Large Type Centri-Cleaners	40	317							17	
	Nicholas-Freeman Vorject Cleaner		319			57					
	Nichola-Freeman Vorvac System	45, 46	319								
	Air Removal								8		
	Deculator System	44, 45	318							18, 20	
	Vorvac System	45, 46									
	Fan Pump	1				6			4	5, 6 7-10	

Section of Paper Mill or Machine	Type of Equipment	Paper Machine Operators Manual	Calkin	Stephenson Volume 1	Stephenson Volume 2	Stephenson Volume 3	Stephenson Volume 4	Papermaking Practice	Fourdrinier Wet Ends	Fourdrinier Papermaking	Discuss O.K.'d
Headboxes											
	General	5, 6, 69	319			102		127	12, 25	12, 37, 64	
	Approach Flow System	6, 49	321			96		128	15	38	
	Screen Dams & Passages					105					
	Flow Eveners	5, 50				119				50	
	Perforated Roll	6, 52, 74	320							52	
	Baffles	8, 52	320								
	Slice	6, 54, 56				96 108 110		141	22 33	55	
	Jet	55									
	Secondary Headbox	60, 69									
Fourdrinier Section											
	General		309, 322			91		144		74	
	Breast Roll	7, 74	322			130					
	Dewatering Roll	75									
	Rolls Box	75									
	Deckles	7	324			141				99	
	Forming Board	7, 29, 75				137			36	82	
	Table Roll	8,, 76	330			122			38	76	
	Flat Boxes	8, 17, 77	330			125					
	Flat Box Vacuum Systems									84	
	Porrier	77									
	Broughton	77									
	Baffles and Deflectors	3, 5, 8, 52				125					
	Dandy Rolls	176	321			137		149	41	100	
	Suction Couch	11, 77	334			143				104, 106	
	Couch Presser Roll	12, 77				144					
	Wash Roll	12	333			130					
	Guide Roll	12	333			130					
	Stretch Roll	13, 66, 22	333			131					
	Savealls (trays)	13	324			141					
	Wire Pits	13, 72	324							3, 31	
	Squirters	13	331			142					
	Wire Guides	13,77	333								
	Mechanically operated										
	Air actuated					131					
	Hydraulic										
	Dominion Mechanical Trim Washer	14									
	Paper Machine Wires	15, 172, 175, 179	322			120 152		157 164			
Suction Pick-up											
	General	95						238		128	
	Suction Roll Covering	265				201				136	

APPENDIX V—PAGES FROM CITY AND GUIDE PUBLICATION 165, 166

Paper and Board Making Practice

Syllabuses

Attention should be given, throughout the course, to safe working methods and to accident prevention. The important contribution of "good housekeeping" methods to safety and to accident prevention should also be stressed.

NOTE: In the "Practice" column of the syllabuses set out below, reference is frequently made to practical experience in the mill and it is intended that this practical experience will normally conform to schemes of training laid down by individual mills. In addition to an understanding of the "Theory" and "Related Studies", a candidate will be expected to have a broad practical knowledge of what goes on in the industry as a whole, together with a more specific knowledge of the processes of his own particular mill. The examination papers will give opportunity for the candidate to drawn on his own industrial experience.

First Year

Theory	*Practice*	*Related Studies*
1.1 *General Introduction to the Industry—Location and Type*		
Broad survey of the products of the paper and boardmaking industry. Outline of the basic processes (without details of machines and equipment).	Tour of Paper Or Board Mill (see B.P.B.M.A. Pamphlet No. 1).	Location of the industry. Factors affecting siting. Relationship between paper and boardmaking and other industries.
2.1 *Power and Water Supplies*		
Uses of water in the industry. Location of mills in relation to availability of power and water supply. Uses of electrical power.	Visit to power-producing plant.	Principles of steam production. Conversion of heat-energy to power.
3.1 *Raw Materials* (*Fibrous*)		
Reasons for using plant fibres. Properties of various papermaking fibres, and when used in relation to paper properties. Simple explanation of isolation methods. List of raw materials, e.g. wood, rags, esparto, straw, waste paper. Basic principles of mechanical and chemical pulping. Processing of rags.	Recognition of chief fibrous raw materials and equipment used in preparation of rag half-stuff."	Where raw materials come from. General plant-structure. Special reference to plants suitable for paper manufacture. Differences between acids and alkalis.

Science and Technology of Paper and Board Making

Papermaking and Boardmaking—Year I

Common raw fibrous materials, elementary types and structure. The principles of conversion to pulp and half stuff. Pulp preparation. Types of pulp as distinguished by their method of preparation. Use of waste paper and board. Principles of bleaching.

Use and function of water in the pulp and paper industry.

Principles of pulp stock conversion into paper. Disintegration. Beating. Refining.

Elementary knowledge of the use of conventional engine sizing materials, loadings, colours, and dyes.

Reasons for stock cleaning prior to conversion into paper. Types of contraries and methods of removal.

Broad principles of sheet and web formation.

Primary removal of water by drainage. Watermaking and dandy rolls. Secondary removal of water by suction and pressure.

The principles of drying and its function. Mid-dryer processes, e.g. tub sizing and size pressing.

Finishing: types of finish and methods used. Calendering, reeling, slitting, cutting, conditioning.

The work of the salle. Despatch of paper and board in sheet and reel form.

Basic properties of paper and board. Elementary treatment of paper and board testing.

Year 2

As for first year, but subjects to be dealt with in a more advanced manner.

Raw fibrous materials—as first year, but to include physical, chemical and microscopic characteristics. Geographical sources and economic aspects of usage. Use of pulp in relation to finished product. Liquor recovery and by-products. Bleaching methods. Reclama-

tion of paper and board for re-use. Introduction to types of equipment used in pulp preparation.

Pulp stock conversion into paper. Types of equipment used for disintegration, washing, beating, refining. Reasons for different methods and types of action involved.

Beater additives for special purposes. Dyes and colours, their uses and properties. Colour matching. Importance of pH and acidity in the role of alum. Extension of first year work to include the chemistry in more detail.

Stock cleaning in more detail than first year, with consideration and recognition of the various methods and types of equipment used.

Study of sheet and web formation in greater detail. Types of machines in use and recognition of their characteristic differences. Further consideration of hand made and mould made paper.

Primary and secondary removal of water: types of equipment used and effects on the finished article.

Backwater and its treatment. Flow diagrams. Treatment methods and reasons.

Drying. Methods and types of machine dryers. Principles of vapour extraction and efficient use of heat.

Finishing—further consideration of first year work. Specialized finishing processes. Fundamentals of conditioning: dimensional stability and the effects of atmospheric conditions.

Machine coating, surface sizing, creping, waxing, mineral coating, laminating.

Properties of paper and board. Testing, methods and equipment.

Sorting, counting, storage and despatch. Methods of packing in reel and ream form.

APPENDIX VI—EXAMPLE OF A CRASH TRAINING PROGRAM FOR TWO ENGINEERS

Introduction

The Papermaking Research Group has promoted the idea of stationing one technical man in each of the outside mills with the object of assisting the mills by the making of measurements and the carrying out of investigations that mill personnel do not have time for. The scheme of work will be set up in collaboration with the mill management in each case. A tentative scheme has been agreed upon with the management of West Carrollton and is attached to this memo as Appendix I. The PMRG man will report to Dr. D. W. Manson, head of the Group.

V. Hentz has joined the Company for the work in the West Carrollton Mill and J. Turnbull for the work in the Lawrence Division. Before either can be set to work on the programs that will be provided a training period is necessary to give them the knowledge of papermaking that will be essential if they are to function effectively. We will actually be trying to provide a depth and width of experience that would normally be gained only after two years or more of effort. As we are going to attempt to do this in four months the program is very intense. Such a program is a challenge to the trainees.

A program was previously drawn up for V. Hentz to follow the similar program laid out for W. Swan of the Lawrence Division. This present program has been designed to permit of the training of V. Hentz and J. Turnbull together; whilst basically the same as the previous program is has been amended and expanded to facilitate the training of two men simultaneously.

Responsibility

The immediate responsibility as training supervisor rests with Dr. D. W. Manson the Group Leader of the Papermaking Research Group. The overall responsibility lies with Mr. J. Mardon who will examine the trainees orally on an approximately *two week* schedule. A written examination paper will be prepared by Dr. D. W. Manson and will be taken by both trainees at the end of the training period.

Length of the Training Program

This must be flexible but in the first instance is aimed at lasting four months. During this period V. Bentz will be asked to spend a short period at West Carrollton—this period will not count as part of the four month program.

(1) Paper Mill Flow Sheets and General Layout

D. W. Manson and J. Mardon spent a week at the Fraser Paper Co. in March and their notes have been written up as a visit report by W. Swan. Some large flow diagrams and general layouts have to be drawn up from blueprints. Read the report and make the necessary drawings after consulting with Mr. R. A. Johnson, Assistant Chief Engineer who has kindly agreed to supervise you on this. After the drawings are completed Mr. Johnson and either Mr. Mardon or Dr. Manson will give you an *oral examination.*

Making out these drawings is intended to give you an idea of what a flow sheet looks like and all the parts are tied together while at the same time helping us by getting out an overdue report. Just making out the drawings, however, will not be very good training you must think as you do the work and try to visualize the questions we will later ask. *Time Allowed*—3 *Days.*

(2) Paper Mill Books

(a) A reading list is attached to the back of this training schedule. We will expect you to have read most of the papers by the time the program finishes. When you get stuck ask Dr. Manson or if he is not available for any reason ask Mr. Mardon. Also attached to the schedule is a list of questions. By the end of your training period we will expect you to be able to provide the answers to any of these questions. *Time Allowed—Evening Work.*

(b) The Papermaking Research Group has developed and refined an inspection procedure manual originally developed by Anglo Paper Products. Please each separately take a blank copy of this book and write in on each page exactly why you think the information that is requested would be of utility and suggest if you can, on pages devoted to more technical questions, what it is that we are actually looking for. *Time Allowed—Evening Work.*

(c) Check the index prepared by W. Swan for the paper mill books against the actual completed

books. It is suggested that each of you take half the machines. The object of this is to prepare a consolidated and efficient index that we can all use. *Time Allowed—2 Days.*

(d) The following items still remain to be completed to bring the paper mill books up to date:
 (1) Check out list below.
 (2) See M. Weeks concerning blower performance curves (see memo attached).
 (3) Obtain present crowns on presses and stacks (See J. Robinson in Maintenance Department).
 (4) Obtain up-to-date Furnish Sheets for all machines.
 (5) Check take-off angles on all machines.
 (6) Check out all the books except #12 to see if index prepared by W. Swan fits. If they do not make corrections to index.
 (7) Check the machines against the books. Note any discrepancies.
 (8) Fill in the efficiencies to date for all machines.

#4 Machine

New Breast Roll (R.B.)
New Slice for 2nd Position
New Wet Press & Size Press Doctors
New Wash Roll Doctors
Not yet
 (as of May 1962)
installed

#5 Machine

Additional Screen and Vortraps (not yet installed—Print of proposal in machine file).

#6 Machine

Calender stack crowning situation (Maint. Dept.)

#9 Machine

Trimbey Dye System (See J. Kimball in Eng. Dept.)

#12 Machine

New Inlet to Headbox—New Screens
Additional Kirtecs
Lengthen Fourdrinier
Not yet installed.

 Caustic control—Alum
 Couch take-off angle
 Time Allowed—2 Weeks

(e) Please read reports 35, 36, 37 and 38 and reports 10, 41 and 42 and summarize the lesson shown by each of the reports in a written paper by D. W. Manson. *Time Allowed—1 Week.*

(f) Examine the Lawrence and West Carrollton books and make up a detailed written list in the form of a memorandum of all the additional data you will need to complete these books. When the memo is finished discuss it with Dr. Manson and if possible with J. Mardon. *Time Allowed—Evening Work.*

(3) Press Tests

(a) Read Press Study Proposal by J. Delisle.
(b) Read all Delisle's Press Reports to date.
(c) Spend a week with Mr. Delisle and the Press Group, make sure that you are thoroughly familiar with what he is doing. You will be required to make similar studies yourselves later in the outside mills.
 Read digest and be prepared to be examined on the papers of Wahlstrom and Chinn.
 You will be required to prepare a press study proposal for the mills to which you will be attached. *Time Allowed—1 Week.*

(4) Drying and Ventilating Studies

(a) Study the dryer proposal by L. E. Robinson; examine the machine in detail then read the report that stemmed from the work done in accordance with the proposal.
(b) If the proposal for No. 12 machine dryer study is not complete, complete it under the direction of Mr. L. E. Robinson. Familiarize yourself with the machine.
(c) Assist Mr. Robinson in making the study. *Time Allowed—3 Weeks.*
(d) Make up a proposal for Machine 9—V. Hentz, 11—J. Turnbull. *Time Allowed—Evening Work.*

Drying and Ventilating is a vital part of the operation of any paper machine and training you obtain in this field will be of the greatest value to you in future. Such surveys are needed in both the outside mills.

(5) Formation Studies

Formation is an important problem for our whole company. Dr. Manson is conducting studies on the machines at Rumford. We have some basis weight and formation samples from West Carrollton and have asked for some from Lawrence. The formation reports written by Dr. Manson are to be read and digested.

We wish to have the samples from the two outside mills analyzed and reports written under Dr. Manson's direction. *Time Allowed—4 Weeks.*

(6) Basis Weight Studies

All the basis weight reports so far written by the PMRG are to be read and the subject matter discussed in detail with R. E. Monahan with whom a special appointment for this purpose should be made (there is enough material for a full afternoon's discussion). Basis weight analysis of the paper samples from West Carrollton (started by W. J. Swan) and Lawrence will be completed and a report will be written. *Time Allowed—2 Weeks.*

(7) General Paper Machine Performance

You are individually to read the proposal of Mr. Robinson and Mr. Cox for the No. 6 machine Quality Improvement Study and are to annotate it. By questioning Messrs. Robinson, Cox, Manson and Mardon you are to try to thoroughly understand the proposal. You are required before posting to the mill to write a paper for us summarizing and criticizing and proposal. *Time Allowed—Homework.*

(8) Wet End Material Balances

(a) Read PMRG 64 which describes Wet End Material Balances and how they are made.
(b) A copy of a set of measurements of flows at West Carrollton for the No. 1 machine is attached. Write a report on these comparing the flows with those in report 35 for the Rumford machines and with the figures in the memo of W. J. Swan for Lawrence. Put in the report the flow diagram for the machine (obtain from J. Mardon). Obtain the other data you need from B. L. Merris

before starting this work.

(c) Consolidate and discuss the material balances made at Rumford *in the light of the report.* It is certain that your future tasks will include the study of flow at the wet end by means of material balances. This consolidation should be written in proper report form and will show what we should have learnt from the studies conducted. Make a proposal for a balance on No. 6 machine and carry it out under the supervision of Mr. C. Cox as part of the No. 6 study. *Time Allowed—3 Weeks.*

(9) *Pamphlet Index*

There is an enormous amount of valuable education material in the literature of the various suppliers to the paper industry. You are required to set up a collection of pamphlets and to index them. This is to be done by sending out a form type letter to advertisers in the trade press. R. E. Monahan has a bunch of typical advertisements ready and the nucleus of the index exists in J. Mardon's office. Consult J. Mardon for detailed instructions on how to proceed. *Time Allowed—Continuous Throughout Length of Program.*

(10) *Literature Survey*

Too many men in the technical side of any industry, and especially our's, tend to rush into a project without thinking it out beforehand and finding out not only what other people have done but how this prior work may be used in helping solve a current problem.

J. Mardon will give you a formal lecture on the use of the literature and the making of a literature survey. Topics selected for you are as follows:—

W. Hentz, Stress String Properties of Wet Webs. A survey exists on this and you are required to bring it up to date.

J. Turnbull, Lubrication of Paper Machines and Associated Equipment. *Time Allowed—2 Weeks.*

A suitable list of references was attached to the program.

APPENDIX VII—FIVE MONTH TRAINING PROGRAM FOR EXPERIENCED MAN

The following is a proposed training program for myself. The total time for it should be about five months. This program is composed from the training programs of V. Hentz, J. Turnbull and W. Swan. Instead of setting up a definite time schedule, I think an overall time limit would be better. This would provide greater flexibility so I may work it around my daily work.

I. *Reading*—Read all the references given in original work program. (*Bibliography attached*).

II. *Press Studies*

(1) Read pertinent papers in Bibliography and work done by press study group.
(2) Discuss with J. C. Delisle any questions.
(3) Attend press meeting on December 13 (above work to be done by then—December 13).

III. *Drying and Ventilation*

(1) Study the dryer proposal by L. E. Robinson, examine the machine in detail then read the report that stemmed from the work done.
(2) Read the references in the bibliography on drying, and the report on measurements at Anglo Canadian. *Proposed Date January 15, 1964.*

IV. *Formation Studies*—This subject should be thoroughly dealt with in conjunction with PMRG 141 (Literature Study of Formation References and Proposed Work Program). *Proposed Date January 15, 1964.*

V. *General Paper Machine Performance*

(1) Read Robinson's and Cox's proposal for #6 machine quality improvement and annotate it.
(2) Be sure to thoroughly understand the proposal.
(3) Write a paper summarizing and criticizing the proposal. *Proposal Date February 15, 1964.*

VI. *Wet End Material Balance*—This should be taken care of in conjunction with drainage work. The completion date here will depend on how the drainage work goes.

VII. *Basis Weight Studies*—Read the pertinent reports in order to understand and evaluate basis weight results. *by March 15, 1964.*

VIII. *Literature Survey*—Should learn about this in conjunction with Formation Work.

IX. *Technical Questions*—I have a list of technical questions which I should be able to answer before the end of the program.

X. *Other*

Any items which come up which may further my technical education by associating with them, should be incorporated into this program as far as reading about them or assisting on any projects. Also, maybe something should be included pertaining to calenders or drives. Since I am taking the RCA electronics course this will probably occupy much of my spare time.

The progress of my studies should be reviewed at least every month. Most of this training program is such that it can be done in my spare time, and should only consume a minimum of working time.

APPENDIX VI

THE EIGHT-YEAR CAREER DEVELOPMENT PLAN - A NEW TOOL IN PERSONNEL MANAGEMENT

DIGEST

It is clearly beneficial to both the company and the employee if he prepares a plan outlining his career objectives and his program for achieving these objectives. The company is more likely to control a highly motivated work force and can, thus, plan its personnel requirements more accurately, and furthermore, the individual is more likely to achieve his objectives. An outline of the components of such a plan is given, and they are believed to consist of:

1. The establishment of objectives

2. The analysis of strengths, weaknesses and areas where experience is lacking

3. The preparation of work schedules

4. Review of the plan

A typical schedule is given for a process engineer who wishes to graduate to an assistant mill manager.

The details of the plan are in the Senate Master Copy only.

INTRODUCTION

The company and the individual employee have a mutual interest in personnel development. The company wishes to supplement its force of capable individuals operating at their optimum level in order to advance and increase profits. The individual wishes to satisfy his income and status requirements, and to experience the feeling that he is making a contribution to his company and to the society of which he is an integral part.

The demands of both parties are more readily achieved if the employee clearly outlines his career objectives and his intended plan of achieving them to his superiors. Such a system has distinct advantages.

I. FOR THE COMPANY

(a) Reduction of Attrition

A two-way channel of communication is opened up and, thus, the risk of loss of capable employees is reduced. If the employee firmly believes that his own personal objectives cannot be fulfilled within his company, he will clearly take action, thus causing undesirable staff turn-over. If, however, the company is aware of the objectives of its employees, various routes can be suggested for their attainment.

It is clear that a company cannot completely eliminate loss of competent employees. Such loss, however, should be restricted to the case where the employer, after careful consideration, cannot satisfy the objectives of the capable employee, thus eliminating the case where the company is unaware of his objectives. Any employee receiving such consideration is less likely to develop hostile feelings towards the company and may, at a later stage in his career, return. Such an argument cannot be applied to an employee leaving his company to take up a position which might have been available to him had his company been aware of his objectives

(b) Recruitment Aid

Companies taking the time and effort to encourage their employees to prepare career objectives and plans are more likely to develop a motivated ambitious work force. Satisfied employees attract others of similar inclination to the company.

Furthermore, the recruiting officer is in a firmer position to explain the role which the company is prepared to play in career development by reference to the plan.

(c) Aid in Forecasting Manpower Requirements and In Detecting Areas Where Shortages are Likely to Occur

If the company is planning expansion, reference to the individual plans will enable the management to determine which employees have an interest in areas requiring staff. Steps can then be taken to supplement the existing staff if this is found to be necessary. Furthermore, if too few employees are preparing themselves for careers within a particular field, this can be detected at a stage sufficiently early for corrective action to be taken. Finally, succession surveys are brought on to a more realistic basis, whereas previously, logical successors may well have accepted positions which were basically unsuitable but where the chance of promotion was the dominating factor. Management can, thus, dovetail the personnel requirements of different departments to a greater extent than waspossible previously.

(d) Aids in Employee Evaluation

Present employee evaluation is often carried out by the position supervisor. In a career plan, the employee sets his own standards and then rates himself by a progress review. A successful achievement record, thus, indicates an employee who is prepared to work to achieve his objectives whereas an unsuccessful record is an indication of a slow worker or a dreamer. Such a system, thus, improves personnel records.

(e) The Responsibility of the Supervisor to Both Company and Employee Are More Clearly Defined

Frequently, a supervisor is faced with the situation in which a capable employee is competently carrying out an assignment which is below his potential and which is, thus, not preparing the employee for advancement. Under such circumstances, the employee will either deteriorate in ability or will leave the company when he realizes what is taking place. Such dangerous situations are easily detected and avoided if the company has a plan outlining the objectives of its employees.

II. FOR THE EMPLOYEE

(a) A Plan Instigates Action

An employee who does not set objectives or make plans is unlikely to succeed. A plan reduces the tendency to intentionally or unintentionally drift since by definition it outlines a definite course of action. It also sets standards by which progress can be measured and it induces the achievement of objectives.

(b) A Plan Makes Maximum Use of Time

A plan accelerates the achievement of objectives. For example, attendance at a convention might offer the opportunity of visiting a nearby plant of special interest, and insures that such opportunities will not go missed.

(c) It Aids in Seeking Alternative Employment

Should the employee feel that his present position does not coincide with his career objectives, the plan is a suitable starting point for:

1. initially making his dissatisfaction known to his company and manipulating a transfer to a different line of work

2. the preparation of a summary to be used in seeking employment outside the company

PLAN COMPONENTS

A career plan is essentially a program designed to fulfil the following:

1. gain experience 9learn by self action)

2. gain knowledge (learn from books)

3. develop contacts (learn from the experience of others by association with them)

In order to establish a program, the individual must:

1. establish his objectives

2. analyze himself and detect areas in which he is weak and areas where he lacks knowledge and experience

3. determine a course of action to overcome these short comings

4. outline a procedure for periodically reviewing his progress

PLAN PREPARATION

Establishment of objectives.

This is the most important and the most difficult part of prepararing a career plan. Objectives should be set high, but not as high that they lie beyond the employee's inherent basic intelligence and work capabilities. Since no one really knows exactly what his "potential" is, it is easy for objectives to be set either too high or too low.* This situation, however, can be avoided to some extent on the basis of a review of objectives with acquaintances who can be depended upon to give an honest assessment. Regardless of the opinions of other,

* Section "Analysis of Strengths and Weaknesses" develops this point more clearly.

however, the employee must set his own objectives. These should span a reasonable space of time; but should not exceed an eight year period which is considered the optimum. Planning for a shorter period of time will limit the scope of the plan and planning for a longer period will involve too many doubtful assumptions.

Objectives will clearly vary with each individual plan, but the following points ought to be considered in plan preparation:

1. The positions the employee intends to hold over the eight year period.

2. The qualifications of the people presently holding these positions.

3. The knowledge and special skills required for these positions.

4. Whether the positions are changing, and whether more personnel will be required in the future.

5. The salary objectives of the employee.

6. The leisure time objectives of the employee.

7. Questions concerning housing location and travelling requirements.

It is important to bear in mind that objectives must be compatible with one another and within the inherent potential of the individual. For example, an employee disliking public speaking and having no desire to travel should not aspire to Director of Public Relations.

In planning objectives for a relatively senior position, it is often helpful for the individual to plan the various routes by which he might advance to this position. This is especially true if the position is three or more levels above that held at present, or if it is in a different line of work.

The reason for doing this, is that on analysis, all routes may not be equivalent, and although a particular route might be ideal from the point of view of experience, it may have a low probability of success if an attempt is made to proceed along it.

Figure I illustrates the various routes considered to exist for a process engineer intending to advance to the position of assistant manager in a paper mill.

Despite the fact that a direct advance would involve only four promotions, there are eleven positions which could be held and a large number of possible combinations available for achieving the final post. Not all routes, however, have an equivalent possibility of success. For example, if at the age of 32, the employee were to accept a position in sales, he might find it difficult to return to the logical channel for the position set as the objective. Similarly, a preponderance of staff rather than line responsibilities might lessen his chances of being considered should the positin become available.

Moreover, certain positions are quite flexible for the first promotion, others are not. For example, the position of Technical Assistant to the Paper Mill Superintendent is a very flexible position while that of Senior Engineer, Sales Service, is not.

In preparing his work schedule, the individual should choose the best route fitting his experience requirements and should prepare himself to proceed along that route. Circumstances might force him to deviate from it, but such action will help guard against him becoming side-branched.

ANALYSIS OF STRENGTHS, WEAKNESSES AND AREAS WHERE EXPERIENCE IS LACKING

The employee should prepare a list of points for and against his established objectives. This list should include:

1. personal characteristis which can be corrected or improved

2. areas where experience has been obtained and where it is required

An example of such a list might be as follows:

1. Strengths

   Related to individual:

   (a) adequate basic intelligence
   (b) willing to work hard
   (c) tolerant towards the views of others

Related to experience:

(a) sound formal education (BSc hons - 1962)
(b) two years as 5th hand on paper machine

2. Weaknesses or Areas Where Experience is Lacking

Related to individual:

(a) tendency to procrastinate
(b) introvert or extrovert tendencies
(c) can be excessively argumentative

Related to experience:

(a) lacks knowledge of instrumentation
(b) mathematics inadquate for future requirements
(c) insufficient personal contact with others in field, etc.

Once strengths and weaknesses have been analyzed, they should be compared to the objectives, and a detailed plan prepared.

PREPARATION OF WORK SCHEDULES

Work plans will vary according to the objectives set by the individual. Typical plans are shown in Tables I to V. These plans are for a hypothetical process engineer, 31 years of age, wishing to achieve the post of Assistant Mill Manager in eight years. His ambition is to advance through a Technical Department into managing mill operations. This intended route is as follows:

1. formal courses of study
2. informal courses (reading and literature reviews)
3. attendance at conventions and visits to other mills
4. plan for personal and professional development
5. plan for technical papers to develop reputation and personal contacts

In the preparation of the schedules, a range of completion dates is used in preference to a specific date, thus increasing the degree of flexibility of the plan. Provision is also made on the schedules for a review.

1. Review of the Plan

The plan will not yield maximum benefits unless it is subjected to periodic review. As positions are terminated, the date should be entered on the schedule together with a short note pertaining to the benefits gained. This serves to make the schedule a progress report.

The plan should be completely reviewed once per year. Should conditions have altered to such an extent that they are no longer appropriate, complete revision of the objectives and schedules should be made.

SUMMARY

A procedure has been detailed whereby an employee outlines his career objectives and his intended means of achieving them. The company thus lowers the probability of losing good staff, adds to its recruiting program, is better able to plan its future while, at the same time, adding to its personnel records at a minimum cost. The employee indirectly improves his personal efficiency and provides himself with a complete and up-to-date record of his achievements. The preparation of development plans are thus mutually beneficial to company and employee provided that such preparation is carried out in a thoughtful and conscientious manner.

TABLE I

FORMAL COURSE OF STUDY

OBJECT	PROBLEM	HOW TO PROCEED	SCHEDULED COMPLETION DATE: EARLIEST DATE	SCHEDULED COMPLETION DATE: LATEST DATE	REVIEW: ACTUAL COMPLETION DATE	REVIEW: REMARKS
Gain knowledge of statistical methods	Inadequate knowledge of statistics --	(1) Contact ______ for references on statistics.	June 1967	July 1967	July 1967	Knowledge now sufficiently complete to handle statistical problems
	Failed to see value of subject in undergraduate years.	(2) Put in request to attend TAPPI, CPPA Statistics Course.	Jan. 1968	Jan. 1969		
		(3) Take Statistics Course	July 1968	July 1969		
Learn basic instrumentation	Rapidly developing field falling behind.	(1) Discuss with ________ of systems engineering dept. and obtain references.	Sept. 1967	Dec. 1967		
		(2) Read and prepare literature review on electronic instrumentation for paper machines.	Dec. 1968	July 1968		
		(3) Attend vendor instrumentation course.	Aug. 1970	May 1971		

TABLE II

INFORMAL COURSE OF STUDY

OBJECT	PROBLEM	HOW TO PROCEED	SCHEDULE COMPLETION DATE: EARLIEST DATE	SCHEDULE COMPLETION DATE: LATEST DATE	REVIEW: ACTUAL COMPLETION DATE	REVIEW: REMARKS
Gain knowledge of scientific paper-making.	Inadequate knowledge of literature	(1) Get Papermaking Reading List from ________	Jan. 1967	June 1967		
		(2) Have ________ note most important papers	Jan. 1967	June 1967		
		(3) Review papers and prepare summaries	Jan. 1967	Jan. 1969		
		(4) Write authors to clarify doubtful points	Jan. 1967	Jan. 1969		
		(5) Meet suppliers of equipment/ obtain brochures	Jan. 1967	Jan. 1969		

TABLE III

PAPERS TO BE WRITTEN

SUBJECT OF PAPER		HOW TO PROCEED	SCHEDULED COMPLETION DATE		REVIEW	
			EARLIEST DATE	LATEST DATE	ACTUAL COMPLETION DATE	REMARKS
Study of Newsprint printability through subjective evaluation	(1)	Review own work done on subject	Jan. 1970	July 1971		
	(2)	Ask ________ and ________ to co-author	Jan. 1970	July 1971		
	(3)	Review literature	July 1970	Dec. 1971		
	(4)	Prepare paper outline	Jan. 1972	June 1972		
	(5)	Draft paper	June 1972	Sept. 1972		
	(6)	Deliver paper at convention	Jan. 1973	Sept. 1973		

TABLE IV

VISITS AND CONFERENCES

PLACE TO BE VISITED	OBJECT	HOW TO PROCEED	SCHEDULED COMPLETION DATE: EARLIEST DATE	SCHEDULED COMPLETION DATE: LATEST DATE	REVIEW: ACTUAL COMPLETION DATE	REVIEW: REMARKS
Rochester Institute of Technology	Study first class printing school	(1) Write ______ at Rochester ______ to introduce	Jan. 1969	Jan. 1970		
		(2) Visit Institute (try to coincide with attendance at convention)	Feb. 1969	Feb. 1970		

TABLE V

PERSONAL DEVELOPMENT

PROBLEM	OBJECT	HOW TO PROCEED	SCHEDULED COMPLETION DATE		REVIEW	
			EARLIEST DATE	LATEST DATE	ACTUAL COMPLETION DATE	REMARKS
Poor at public	Become proficient	Join Toastmasters Club	Sept. 1967	Sept. 1968		

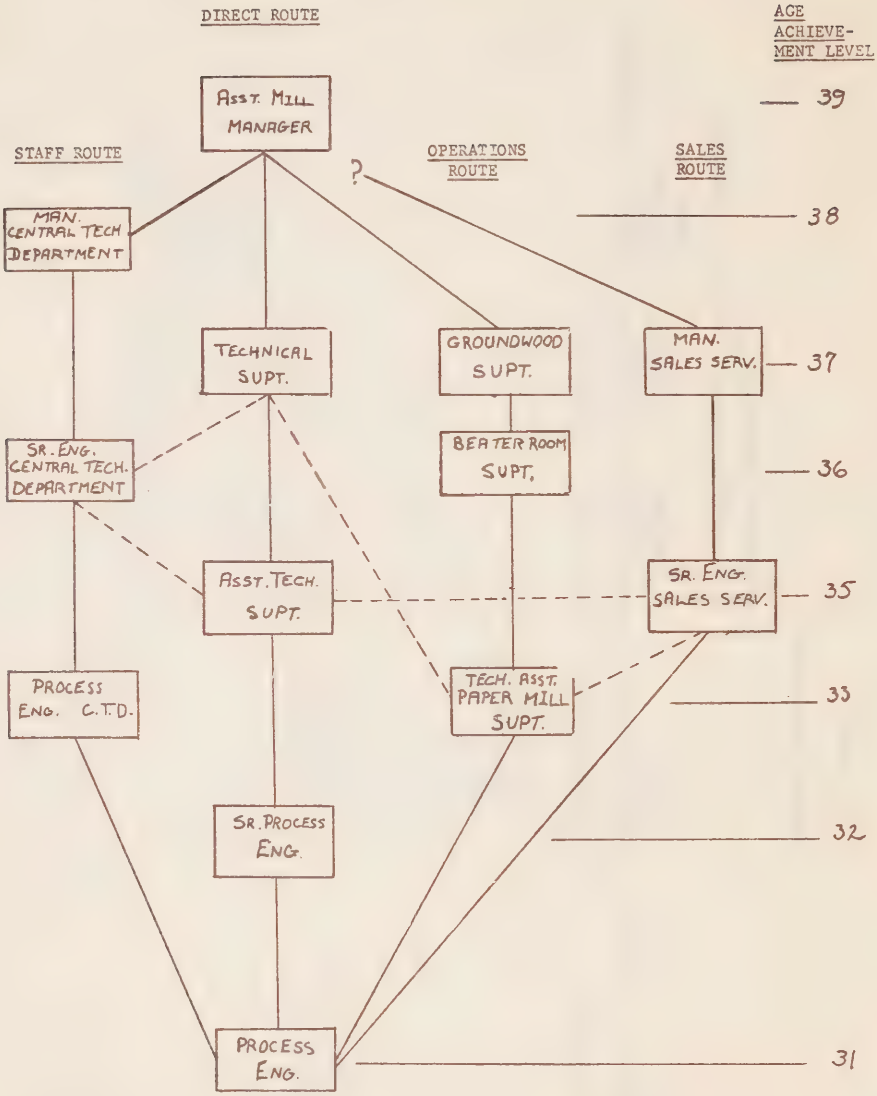


Figure [1] Hypothetical advancement routes for process engineer deserving to advance to the position of assistant Mill Manager in 8 years.

APPENDIX VII

TEXTBOOKS OF SCIENCE COURSES
GRADES 11 AND 12, ENGLISH SCHOOLS

To further illustrate the need to improve the scientific standards reached by high school science graduates, the Appendix describes science textbooks, used in English schools, which should be compared with similar Canadian textbooks in use.

The full Appendix is provided in the Senate Master Copy only.

CHEMISTRY DEPARTMENT

Books used in the "A" Level course.

ORGANIC CHEMISTRY

1. A New Organic Chemistry for Schools and Colleges
by Heys (Harrap Publisher)

Full course in Alephatic and Aromatic Chemistry
A weakness - little on the mechanism of organic reactions.

2. Organic Chemistry
by Waddington (Mills and Boon)

For full details see later.

An excellent book - contents as above, but with the addition of chapters on "Chemicals from Oil", "Chemicals from Coal" and "Polymers". "The Electronic Theory of Organic Mechanism" is also introduced.

3. Organic Chemistry
by Wood and Holliday (Butterworth)

Deals with Reaction Mechanism well.

4. Organic Chemistry Through Experiment
by Finlay and Waddington (Mills and Boon)

Comprehensive range of experiments in Alephatic and Organic Chemistry, together with Oil and Coal Experiments, Plastics and Chromatography design for "Quick-Fit" B14 semi-micro scale apparatus.

INORGANIC CHEMISTRY

1. Essentials of Sixth Form Inorganic Chemistry
by David Abbott (Dent)

For full details see later.

A "first-rate" book with elements dealt with from the point of view of periodic group characteristics. Other excellent chapters on "Chemical Bonding", "Electro-chemical Series", "Oxidation and Reduction"

2. Inorganic Chemistry
by Wood and Holliday (Butterworth)

Also dealt with from point of view of Periodic Table characteristics, but thoroughly up-to-date in its approach.

3. Practical Inorganic Chemistry
by David Abbott (Dent)

Tests for ions grouped according to the Periodic Classification, with details of preparations of a wide range of inorganic compounds.

PHYSICAL CHEMISTRY

1. Physical Chemistry
by Heys (Harrap)

Principles lucidly explained along up-to-date lines using the following topics:

(a) chemical and physical evidence for the particulate theory of matter

(b) molecular weights in gaseous and solution state

(c) atomic structure and bonding

(d) the solid, gaseous and liquid states

(e) polymorphism and allotropy

(f) solubility

(g) the colloidal state

(h) thermochemistry - basic ideas of thermodynamics

(i) reaction kinetics - equilibrium

(j) the ionic theory

(k) the electrochemical and redox series

2. Physical Chemistry
by Wood and Holliday (Butterworth)

An excellent companion to "Inorganic Chemistry" by Wood and Holliday (Butterworth).

3. Practical Physical Chemistry
by David Abbott (Dent)

Full range of experiments described simply and clearly. Chromatography (Column, Paper, Thin Lay and Gas) is featured.

ADDITIONAL

1. Inorganic and Physical Chemistry
by Holderness (Heinemann)

A very good general book, with both sections dealt with along the usual lines - all equations are ionic. Very readable and the Inorganic Chemistry interestingly applied.

2. Essentials of Sixth Form Chemistry (Inorganic)
by David Abbott

Chapters

1. Atomic Structure
2. Early Classification of Elements
3. Modern Periodic Table
4. Electronic Arrangement and the Periodic Table
5. Valency, Chemical Bonds and Crystal Structure
6. Oxidation and Reduction
7. The Electrochemical Series
8. Metals and Non Metals
9. Electronegativity and Related Topics
10. The Rare Gases: Group O
11. Hydrogen
12. Group IA Alkali Metals
13. Group IB Coinage Metals
14. Group IIA
15. Group IIB
16. Group IIIB
17. Group IVB
18. Group VB
19. Group VIB
20. Group VIIB Halvgens
21. Transition Elements

3. Organic Chemistry
by Waddington (Mills and Boon)

Chapters

1. Introduction
2. Rep. and Purification of Organic Compounds
3. Paraffin Hydrocarbon
4. Clefines
5. Acetylenes
6. Alkyl Halides
7. Other Halogen Derivatives of Hydrocarbons
8. Alcohols
9. Ethers
10. Aldehydesand Ketones
11. Monocarbonylic Fatty Acids
12. Salts of Fatty Acids
13. Derivates of Fatty Acids
14. Amines
15. Alkye Cyanides
16. Alkyl Isocyanides
17. Metroaraffins
18. Esters of Inorganic Acids
19. Substituted Fatty Acids
20. Carbonic acid, carbamic acid and Their Derivatives
21. Polyhydric Alcohols
22. Clefine Oxides
23. Saturated Dicarboxylic Acids
24. Isomerism
25. Carbohydrates
26. Gregnard Reagents
27. Atomic Structure and Valency
28. Electronic Theory of Organic Chemistry
29. Aromatic Organic Chemistry
30. Aromatic Hydrocarbons
31. Aromatic Metrocompounds
32. Aromatic Amines
33. Diazonium salts
34. Aromatic Halogen Compounds
35. Aromatic Sulphonic Acids
36. Phenols
37. Aromatic Alcohols
38. Aromatic Aldehydesand Ketones
39. Aromatic Acids and Their Derivatives
40. Oil
41. Chemicals from Oil
42. Chemicals from Coal
43. Polymers
44. Analysis of Elements in Organic Compounds
45. Important Reactions

PURE MATHEMATICS: A FIRST COURSE
by J. K. Backhouse and P. T. Houldsworth (Longmans)

1. Coordinates and the Straight Line
2. The Gradient of a Curve
3. Velocity and Acceleration
4. Maximas and Minima
5. Integration
6. Further Differentiation
7. Integration by Summation
8. Some Useful Topics in Algebra
9. Permutations and Combinations
10. Series
11. The Binomia Theorem
12. The General Angle and Pythajoras' Theorem
13. Compound Angles
14. The Factor Formulae
15. Solution of Triangles
16. Radians
17. Loci
18. The Circle
19. Further Topics in Coordinate Geometry
20. Variation and Experimental Laws

PURE MATHEMATICS: A SECOND COURSE
by Backhouse, Houldsworth and B. E. Cooper

1. Integration
2. Experimental and Lojarithmic Functions
3. Partial Fractions
4. The Binomial Theorem
5. Probability
6. Three-Dimensional Geometry and Trigonometry
7. Some Inequalities and Graphs
8. Further Equations and Factors
9. Coordinate Geometry - I
10. Series for e^x and $\log_e$ (ltx)
11. Further Differentiation
12. Further Trigonometry
13. Further Integration
14. Projection
15. Mersuration and Moments of Inertia
16. Coordinate Geometry - II
17. Differential Equations
18. Approximations - Further Expansions in Series
19. Some Numerical Methods
20. Hyperbolic Functions
21. Some Geometrical Applications of Calculus
22. Complex Numbers

<u>ELEMENTARY MECHANICS</u>
by Quadling and Ramsay, Vol. I (Bell)

1. Velocity and Acceleration
2. Forces and Diagrams
3. Force and Acceleration
4. Forces at an Angle
5. Rough Surfaæs
6. Large Bodies
7. Vectors and Relative Velocity
8. Projectiles
9. Force as a Vector
10. Three Forces on a Large Body
11. The Angle of Friction
12. Interacting Bodies
13. Momentum
14. Methods of Combining Forces
15. Centre of Gravity
16. Energy and Power
17. Machines

<u>ELEMENTARY MECHANICS</u>
by Auadling and Ramsay Vol. II (Bell)

18. Motion in a Straight Line
19. Motion in a Circle
20. Elasticity
21. Oscillations
22. Rotation
23. Moments of Inertia
24. Internal Stresses in Beams
25. Stresses in Light Frameworks
26. The Mechanics of Fluids
27. Units and Dimensions
28. Miscellaneous Statics
29. Velocity and Acceleration in Two Dimensions
30. Constrained Motion in Two Dimensions
31. Free Motion Under Gravity
32. Interacting Bodies in Motion
33. Applications of the Energy Principle

STATISTICS: A FIRST COURSE
by R. Loveday C.U.P.

1. Frequency Distributions
2. Cumulative Frequency Distributions
3. Measures of Location
4. Measures of Dispersion
5. Regression
6. Correlation by Product-Moments
7. Correlation by Ranks
8. The Analysis of a Time-Series
9. Weighted Averages
10. Miscellaneous Topics
11. Miscellaneous Problems

STATISTICS: A SECOND COURSE
by R. Loveday C.U.P.

1. The Normal Distribution
2. Probability
3. Random Selections
4. The Binomial Distribution
5. The Poisson Distribution
6. The x^2 - Distribution
7. The Use of x^2 in Testing Contingency Tables
8. Samples and Significance
9. Quality Control
10. Method of Least Squares
11. Correlation of Product-Moments
12. Correlation by Ranks
13. Miscellaneous Exercises

BOTANY

LOWSON'S TEXTBOOK OF BOTANY
Revised Simon, Wormer and Hartshorne 14th Edition
(University Tutorial Press)

Chapter

1. The Scope and History of Botany
2. Cells and Tissues
3. The Shoot in Vascular Plants
4. The Structure of Stems
5. The Structure of Roots
6. Seeds and Seedlings
7. The Structure of Leaves
8. Cytology
9. The Plant in Relation to Water
10. Metabolism
11. Growth and Developments
12. Reproduction in Angiosperms
13. Classification and Identification of Angiosperms
14. Survey of the Plant Kingdom - Introduction
15. Bryophytes

    (a) Hepatical (liverworts)
    (b) Musci (mosses)

16. The Pteirdophytes

    (a) Ferus
    (b) Horsetails
    (c) Lycopods

17. Cymmosperms

    (a) Coutfus
    (b) Cycads
    (c) Giukgo
    (d) Guctales

18. Algae

    (a) Chlorophyceae
    (b) Phaeophycaee
    (c) Rhodophyceae
    (d) Myrophyceae
    (e) Xaultophyceae
    (f) Bacillariophyceae (Diatours)
    (g) Englenophyceae
    (h) Economic Importance of Algae

19. Fungi, Bacteria and Viruses

(a) Sapicliguia
(b) Pythium
(c) Phytophthora
(d) Peronospora
(e) Alkugo
(f) Mucor
(g) Aspergillus
(h) Penicillium
(i) Erysiphe
(j) Monilinia
(k) Saccharoiuyels
(l) Pucciuia
(m) Agariars
(n) Mycorrhizas
(o) Licheus
(p) Bacillus Subtilis
(q) Viruses

20. Survey of the Plant Kingdom - Epilogue
21. Plant Ecology
22. Genetics and Evolution

Comments

A useful textbook which covers fully the requirements of the Botany syllabus of the University of London. The approach rather like the old Zoology syllabus, is taxonomic involving the study of a number of "type organisms". Greater emphasis is being placed on biological principles in our teaching and one anticipates a revision of the Botany syllabus towards this end in the near future.

ZOOLOGY

ANIMAL BIOLOGY

by Grove and Newell (University Tutorial Press)

Chapter

1. Introduction
   - (a) Physics and Biology
   - (b) Molecular Genetics
2. The Cell and Cell Cycle
   - (a) Development, Differentiation and Morphogenesis
3. The Principles Upon Which Animals are Classified
   - (a) Taxonomy
4. Lowly Animals - Protozsa
   - (a) Amoiba
   - (b) Differences Between Animals and Plants
   - (c) Paramecium
   - (d) Monocystis
   - (e) Malarial Parasite
   - (f) Sexual Processes in the Protozoa
   - (g) Entamoeba Histolytics
   - (h) Trypanosoimes
   - (i) Englena
   - (j) Behaviour of the Protozoa
5. The Many-Celled Animals - Metazoa
6. The Two-Layered Animals - Diploblastica
   - (a) (Colleuterata)
   - (b) Introduction
   - (c) Hydra
   - (d) Obelia
7. The Three-Layered Animals - Triploblastica
8. The Flatworms - Platyhelmiuthes

(a) Turbellana
(b) Parasitic Flatworms
(c) Ectoparasitics Flukes - Monogenea
(d) Endoparasitic Flukes - Digenea
(e) Fascisea Hepatica
(f) Cestoda
(g) Taenia Solium
(h) Other Tapeworms

9. Roundworms - Neuratoda

(a) Introduction
(b) Ascaris
(c) Other Nematodes

10. Parasitism
11. The Coclomate Animals
12. The Segmented Worms - Annclida

(a) Polychaeta - Neries
(b) Oligochaeta - Luimpucus

13. The Jointed Limbed Animals - Arthropoda

(a) Introduction
(b) Cuistacea - The Crayfish
(c) Other Crustacea
(d) The Cockroach - Periplaneta
(e) Some Other Insects

14. Mollusca

(a) Introduction
(b) Helix Aspersa
(c) Classes of Molluses

15. The Chordate Animals

(a) Introduction
(b) Differences Between Chordate and Non-Chordate Animals

16. Simple Chordate Animals - Acramia

(a) Introduction
(b) Cephalochordata - Branchiostoma
(c) The Affinities of the Cephalochordates

17. The Vutebrate Animals - Craniata

(a)q Introduction
(b) Histology
(c) External Features
(d) The Skin
(e) Metamerism
(f) The Skeleton
(g) Muscles
(h) The Body Cavity
(i) The Alimentary System
(j) Histology of the Gut and Associated Glands
(k) Nutrition
(l) The Blood Vascular System
(m) Histology and Physiology of Blood
(n) The Respiratory System
(o) The Neuro-Sensory System
(p) Histology and Physiology of Nervous Tissue
(q) The Sensory System
(r) The Renal and Reproductive Systems
(s) Histology and Physiology of the Kidneys
(t) Histology of the Gonads
(u) The Endocrive System - The Ductlers Glands

18. The Germ Cells - Gametogenesis

(a) Introduction
(b) Gametogenesis
(c) Meiasis
(d) The Significance of Maturation and Fertilization

19. The Development of the Vertebrates - Chordate

(a) Embryology
(b) Introduction
(c) The Developmenttof Amphioxus (Branchiostoma)
(d) The Development of the Frog
(e) The Development of the Chick
(f) The Development of Mammals
(g) The Development of the Rabbit

20. Genetics

(a) Introduction
(b) Heritable Characters and Their Behaviour
(c) Mutations

21. The Interrelations and Origins of Animals - Organic Evolution

    (a) Introduction
    (b) The Fact of Change
    (c) The Extent of Change
    (d) Evidence From Classification
    (e) Evidences From Geology and Palaeontology
    (f) Evidences From Comparative Morphology and Anatomy
    (g) Evidences From Embryology
    (h) Evidences From Geographical Distribution
    (i) Evidences From Comparative Physilogy and Genetics
    (j) The Way in Which Evolution Has Come About

22. Ecology
23. The Main Groups of Animals

    (a) Selected Further Reading
    (b) Index

Comments

This was the standard textbook for the Zoology syllabus of the University of London which demanded detailed knowledge of a number of "type animals". A new syllabus was introduced in 1967 for examination for the first time in June 1969. In the new syllabus the "type" approach has been abandoned in favour of a study of grades of organization. Emphasis has been shifted from descriptive anatomy to comparative physiology with the underlying aim of relating structure to function. For the new syllabus animal biology is a less useful textbook but in the absence of a new textbook specifically written for the new syllabus still the best available.

THE QUEEN'S PRINTER, OTTAWA, 1969

First Session—Twenty-eighth Parliament

1968-69

THE SENATE OF CANADA

PROCEEDINGS

OF THE

SPECIAL COMMITTEE

ON

SCIENCE POLICY

The Honourable MAURICE LAMONTAGNE, P.C., *Chairman*
The Honourable DONALD CAMERON, *Vice-Chairman*

No. 76

THURSDAY, JUNE 26th, 1969

WITNESSES:

Royal Architectural Institute of Canada: Dr. Thomas Howarth, Dean of the Faculty of Architecture, University of Toronto. *Canadair Limited:* Mr. R. J. Ross, Chief Development Engineer; Mr. F. C. Phillips, Program Manager. Mr. Gordon B. Thompson, Northern Electric, Research & Development Laboratories; Mr. J. P. I. Tyas, Office of Science and Technology, Department of Industry, Trade and Commerce; Mr. H. C. Campbell, Chief Librarian, Toronto Public Libraries; Dr. A. B. Hunt, Member, National Research Council; Professor C. Forget, Centre de Documentation, Laval University, Quebec, Quebec; Mr. H. J. von Baeyer, Acres Intertel Limited.

APPENDICES:

185—Brief submitted by Royal Architectural Institute of Canada.
186—Brief submitted by Mr. Gordon B. Thompson.

20676—1

MEMBERS OF THE SPECIAL COMMITTEE

ON

SCIENCE POLICY

The Honourable Maurice Lamontagne, *Chairman*

The Honourable Donald Cameron, *Vice-Chairman*

The Honourable Senators:

Aird
Belisle
Blois
Bourget
Cameron
Carter
Desruisseaux
Giguère
Grosart
Haig
Hays
Kinnear
Lamontagne
Lang
Leonard
McGrand
Nichol
O'Leary (*Carleton*)
Phillips (*Prince*)
Robichaud
Sullivan
Thompson
Yuzyk

Patrick J. Savoie,
Clerk of the Committee.

ORDERS OF REFERENCE

Extract from the Minutes of the Proceedings of the Senate, Tuesday, September 17th, 1968:

"The Honourable Senator Lamontagne, P.C., moved, seconded by the Honourable Senator Benidickson, P.C.:

That a Special Committee of the Senate be appointed to consider and report on the science policy of the Federal Government with the object of appraising its priorities, its budget and its efficiency in the light of the experience of other industrialized countries and of the requirements of the new scientific age and, without restricting the generality of the foregoing, to inquire into and report upon the following:

(*a*) recent trends in research and development expenditures in Canada as compared with those in other industrialized countries;

(*b*) research and development activities carried out by the Federal Government in the fields of physical, life and human sciences;

(*c*) federal assistance to research and development activities carried out by individuals, universities, industry and other groups in the three scientific fields mentioned above; and

(*d*) the broad principles, the long-term financial requirements and the structural organization of a dynamic and efficient science policy for Canada.

That the Committee have power to engage the services of such counsel, staff and technical advisers as may be necessary for the purpose of the inquiry;

That the Committee have power to send for persons, papers and records, to examine witnesses, to report from time to time, to print such papers and evidence from day to day as may be ordered by the Committee, to sit during sittings and adjournments of the Senate, and to adjourn from place to place;

That the papers and evidence received and taken on the subject in the preceding session be refered to the Committee; and

That the Committee be composed of the Honourable Senators Aird, Argue, Bélisle, Bourget, Cameron, Desruisseaux, Grosart, Hays, Kinnear, Lamontagne, Lang, Leonard, MacKenzie, O'Leary (*Carleton*), Phillips (*Prince*), Sullivan, Thompson and Yuzyk.

After debate, and—

The question being put on the motion, it was—

Resolved in the affirmative."

20676—1½

Extract from the Minutes of the Proceedings of the Senate, Thursday, September 19th, 1968:

"With leave of the Senate,

The Honourable Senator Lamontagne, P.C., moved, seconded by the Honourable Senator Benidickson, P.C.:

That the name of the Honourable Senator Robichaud be substituted for that of the Honourable Senator Argue on the list of Senators serving on the Special Committee on Science Policy.

The question being put on the motion, it was—
Resolved in the affirmative."

Extract from the Minutes of the Proceedings of the Senate, Wednesday, February 5th, 1969:

"With leave of the Senate,

The Honourable Senator McDonald moved, seconded by the Honourable Senator Macdonald (*Cape Breton*):

That the names of the Honourable Senators Blois, Carter, Giguère, Haig, McGrand and Nichol be added to the list of Senators serving on the Special Committee on Science Policy.

The question being put on the motion, it was—

Resolved in the affirmative."

ROBERT FORTIER,
Clerk of the Senate.

MINUTES OF PROCEEDINGS

THURSDAY, June 26, 1969.

Pursuant to adjournment and notice the Special Committee on Science Policy met this day at 8.00 p.m.

Present: The Honourable Senators Lamontagne (*Chairman*), Belisle, Carter, Grosart, Cameron and Robichaud—(6).

In attendance:

Philip J. Pocock, Director of Research (*Physical Science*).

The following witnesses were heard:

Royal Architectural Institute of Canada: Dr. Thomas Howarth, Dean of the Faculty of Architecture, University of Toronto.

Canadair Limited: Mr. R. J. Ross, Chief Development Engineer; Mr. F. C. Phillips, Program Manager.

Mr. Gordon B. Thompson: Northern Electric Research & Development Laboratories.

Mr. J. P. I. Tyas: Office of Science and Technology, Department of Industry, Trade & Commerce.

Mr. H. C. Campbell, Chief, Librarian, Toronto Public Libraries.

Dr. A. B. Hunt, Member, National Research Council.

Professor C. Forget, Centre de Documentation, Laval University, Quebec, Quebec.

Mr. H. J. von Baeyer, Acres Intertel Limited.

(*A curriculum vitae of each witness follows these Minutes*)

The following are printed as Appendices:

No. 185—Brief submitted by Royal Architectural Institute of Canada.

No. 186—Brief submitted by Mr. Gordon B. Thompson.

At 10.35 p.m. the Committee adjourned to the call of the Chairman.

ATTEST:

Patrick J. Savoie,
Clerk of the Committee.

CURRICULUM VITAE

Von Baeyer, Hans Jacob, Ph.D., P. Eng., Fellow, I.E.E.E.—*Education*: University of Heidelberg, 1935. *Professional experience*: 1935-1945, Telefunken, Germany. Research and Developments Labs. 1945-1952, Brown Boveri and Co., Switzerland. Head of microwave development group. Development of radio relay communications systems for Swiss Post Office and Swiss military authorities. 1952-1955, Canadian Government, Department of National Defence. Chief Systems Engineer, Pinetree Project Office (a joint Canada-U.S. defence agency). Planning, engineering and installation of tropospheric scatter communications system in the sub-Arctic. 1955-1958, Chief Engineer, Systems Planning Group, R.C.A.F. Planning, engineering and installation of the Mid-Canada Line. 1958-1960, Systems Engineer-in-Chief, R.C.A.F. Planning of continental communications systems for Air Defence Command. 1961-1962, Consultant in communications to the Royal Commission on Government Organization (Glassco Commission). Analysis of methods of message handling, data and voice communications, and recommendations for improvement. 1961-1967, President, InterTel Consultants Ltd., Ottawa, Ontario. Consultant to D.D.P. on Development Sharing Program (Army tactical radio relay equipment AN/GRC 103 design). Consultant to Interdepartmental Committee on Defence Communications (ICDC) on evaluation of Defence Communications Study. 1967, President, Acres InterTel Limited, Ottawa, Ontario. Consultant to Science Secretariat on Study of Scientific Technical Information in Canada, Chairman of Economic Subgroup.

Campbell, Henry Cummings.—Born Vancouver, B.C. B.A., University of British Columbia, 1940; B.L.S., University of Toronto, 1941; M.A., Columbia University, 1948. Librarian, National Film Board, Ottawa, 1942-1944, and producer in charge of overseas film production, 1944-1946. Employed from 1947-1956 with United Nations (New York), and Unesco (Paris) as programme specialist to develop library services in Member States. In the course of these duties, carried out Unesco-Library of Congress World Survey of Bibliographical Services, 1949-1951. In charge of the publication of the *Unesco Bulletin for Libraries*, 1951-1956, the *Unesco Handbook on the International Exchange of Publications*. During 1953-1955 advised on the programme of aid to libraries in under-developed countries as part of the technical assistance programme of the United Nations and Specialized Agencies. Visited scientific and technical libraries and documentation centres in Europe, Latin America and the Middle East. Acted as specialist in bibliography and documentation in connection with the International Federation for Documentation, 1953-1956. Appointed Chief Librarian, Toronto Public Libraries, September, 1956. Member of the Canadian Unesco National Commission, and of its Executive Committee, 1957-1959. Member of the Research Committee of the Canadian Institute for International Affairs, Advisory Committee on Scientific Information of the National Research Council, 1959-1967. Member of Science Secretariat Study on Scientific and Technical Information in Canada, 1967-1969. Editor of *Metropolitan Public Library Planning Throughout the World*, Pergamon Press, Oxford; *How to Find Out About Canada*, Pergamon Press, Oxford; author of *Canadian Libraries*, McClelland & Stewart, Toronto, 1969; Editor,

Developments in National Document and Information Services, Library Trends, January 1969, University of Illinois, Urbana.

Forget, Guy.—Born: Ste. Agathe, P.Q., April 26, 1911. Classical Education: Collège Ste. Marie. Mont-Laurier Seminary (B.A.). Law: University of Montreal (2 years). Library Science: University of Montreal (B.L.S.). Married, four children. *Intramural Activities:* Director, Documentation Centre, Laval University. Entrusted, in 1963, with the establishment, organization and administration of a centre to provide multi-disciplinary documentation for research and teaching purposes. *International Professional Activities:* One of four consultants appointed by UNESCO in connection with a changeover to automated techniques at the Library in Florence, Italy. Member of the standing committee on information and documentation of the Association of Partially or Entirely French-speaking Universities (AUPELF). Member of the American Society for Information Science. Member of the International Documentation Association. *Other Professional Activities:* Chairman of the Special Committee on Liaison between the Canadian Library Association and the Canadian Association of French-Language Libraries. Chairman of the Training Committee of the Professional Librarians' Association of Quebec. Chairman of the Quebec Universities Co-ordinating Committee on Documentation. Member of the Task Force on Scientific and Technical Information in Canada (Privy Council Science Secretariat); Chairman of the University Sub-Committee. Member of the C.A.F.-L.L. Member of QUEFRATEC. Member of the Automation Committee of the Canadian Association of College and University Libraries (CACUL). *Extramural Activities:* Has lectured at numerous symposia and conferences on library science and data-processing techniques in Canada and the United States. Conducted a series of lectures in Paris on the use of microfilm in information retrieval. Gave the inaugural lecture at a "Clinic on Library Applications of Data Processing" at the University of Illinois, May 5, 1968. *Previous Activities:* Librarian with the federal Government from 1946 to 1963. In charge of publication of the list of subject headings for the French catalogue of the Library of Parliament.

Howarth, Dr. Thomas.—Dr. Thomas Howarth studied architecture and town planning at the University of Manchester, and read for the degree of Doctor of Philosophy at Glasgow University. For seven years he taught at the Glasgow School of Architecture, and also directed an evening course in Interior Design at the Glasgow School of Art. In 1946 he returned to Manchester University and, subsequently, was appointed Senior Lecturer in Architecture with special responsibility in architectural design and history. As author of "Charles Rennie Mackintosh and the Modern Movement", published in London and New York, he was the first non-American to receive the Annual Book Award of the Society of Architectural Historians and the Alice Davis Hitchcock Memorial Plaque. In 1952 he was awarded the R.I.B.A. Alfred Bossom Research Fellowship and made a study of the use of ceramics in modern architecture. He is at present working on a history of 19th and 20th century architecture. Dr. Howarth has travelled widely in Europe and the Far East. He spent a year (1955-56) in the U.S.A. and Canada as a Rockefeller Foundation Scholar visiting as lecturer and critic many university schools of architecture including Harvard, M.I.T., Yale, Princeton and Berkeley in order to examine North American educational philosophy and methods. In 1953 he was invited to the Chair of Architecture, University of Toronto, as successor to Colonel H. H. Madill. Under Dr. Howarth's direction the School has grown considerably in strength and in 1967 attained

the status of Faculty with three departments—Architecture, Urban & Regional Planning and Landscape Architecture. Dr. Howarth is Vice-President of the Association of Collegiate Schools of Architecture (U.S.A.) and chairman of the ACSA's five-man Committee on the Advancement of Architectural Education. He is a member of the Board of Architectural Education of the Commonwealth Association of Architects and represents the Commonwealth on the Joint Committee on Architectural Registration. He was recently appointed to the National Capital Commission by the Governor in Council and he is Chairman of the N.C.C. Advisory Committee on Design which reviews major civic design proposals, individual buildings, highway engineering and other works projected for the Canadian capital city, Ottawa. He is the master planner of Laurentian University, Sudbury, Ontario; adviser to the Board of Governors of York University, Toronto; consultant to the University of Western Ontario. He is a member of the Registration Board of the Ontario Association of Architects. Dr. Howarth is a Fellow of the Royal Architectural Institute of Canada and serves on the Education Committee and the Research Committee. He is a Fellow of the Royal Institute of British Architects.

Hunt, A. Brewer, B.A. Sc., D. Eng., F.E.I.C., F.I.E.E.E. Dr. Hunt was born in London, Ontario, in 1902. He graduated from the University of Toronto in 1928 with the degree of Bachelor of Applied Science, and received the medal award from the British Association for the Advancement of Science. Immediately following graduation, Dr. Hunt joined the Northern Electric Company as a manufacturing methods engineer. He held many senior engineering and management positions with the Company and, from 1960 until his retirement in 1967, held the position of Vice-President, Research and Development, in charge of the Company's laboratories in Ottawa. Dr. Hunt was awarded the Engineering Institute's Ross Memorial Medal, in 1946, for his paper entitled "The Future of Radio Communications in Canada". In 1954 he was loaned to the Government for a period of eighteen months as Director of the Electronics Branch of the Department of Defence Production. In 1966, Dr. Hunt was named a member of the National Research Council of Canada. He is retired Commanding Officer of the 11th Signals Regiment (Reserve); a Past President, Director, and Chairman of the Research Committee of Electronic Industries Association of Canada; past Vice-President, Research and Development Division of the American Management Association; a member of the Industrial Research Committee of the Ontario Economic Council; a member of the Research and Development Committee of the Canadian Manufacturers' Association; and a member of the advisory boards of the Faculty of Science of the University of Ottawa, the College of Engineering of Saskatchewan University, and the Materials Research Unit of McMaster University. He is a member of the Association of Professional Engineers of Ontario, the Institute of Electrical and Electronic Engineers, the American Association for the Advancement of Science, and a Fellow of the Engineering Institute of Canada.

Phillips, Frederick C., Program Manager CL-84 at Canadair, is a United States citizen born in Pennsylvania in 1915. He was educated at New York University graduating *magna cum laude* with the degree of Bachelor of Aeronautical Engineering at the Massachusetts Institute of Technology. He is a member of Psi Upsilon, Iota Alpha and Tau Beta Pi. From 1939-47, he was an aerodynamicist with the Glenn L. Martin Company at Baltimore, Maryland and during that same period in the years 1942-44, he was an instructor in aeronautical engineering at the Johns Hopkins University. In 1947, as a

member of the faculty group responsible for the organization and initial operation of the Institute of Technical Aeronautics for the Brazilian Air Ministry in Rio de Janeiro, he was Professor-in-charge of the Department of Aircraft Design, and technical consultant. He left Brazil in 1951 and joined McDonnell Aircraft Corporation at St. Louis, Missouri, where he was progressively test engineer, senior design engineer and operations analyst in the Helicopter Engineering Division. He joined Canadair in 1955 as Chief of Aerodynamics & Preliminary Design, was appointed Project Engineer - CL-41 Trainer in 1957; Assistant Chief Engineer, Technical in 1959; Director Research & Development in 1960. He received his present appointment in September 1963. He is a Fellow and Past President of the Canadian Aeronautics & Space Institute and an Associate Fellow of the American Institute of Aeronautics and Astronautics. He is a member of the American Helicopter Society.

Ross, Robert James, D.C.Ae, M.I. Mech. E, A.F. C.A.S.I., C. Eng., P. Eng.—Robert James Ross, Chief Development Engineer at Canadair, is a Canadian citizen, born at Farnham, England. He attended the Royal Aircraft Establishment Technical College, Farnborough, England, from 1941 to 1946, where he received Higher National Certificates in Mechanical & Aeronautical Enginering and the R.A.E. Diploma in Engineering. He then completed two years post graduate study at the College of Aeronautics, Cranfield, England, receiving his D.C.Ae in 1948. He began his career as a scientific officer with the Ministry of Supply in the Aerodynamics Flight Section at the Royal Aircraft Establishment, Farnborough, engaged on aerodynamics research in flight. In 1952, he joined Canadair as an Aerodynamics Engineer. In the ensuing years, he has held various posts in the Engineering Division of Canadair, including those of Chief Dynamics & Flight Test Engineer and Director, Research & Development. He received his present appointment in May 1969. He was a member of the NRC Associate Committe on Aerodynamics for 3 years, and is currently a member of the Research & Development Committee of the Aircraft Industries Association.

Thompson, Gordon B.—Gordon B. Thompson is a Senior Member of Scientific Staff with the Northern Electric Research and Development Laboratories in Ottawa, and is currently exploring the relationships between communications technology and society. He received his degree in Engineering Physics from the University of Toronto in 1947 and joined the Northern Electric Company upon graduation, where for many years he was engaged in the design of radio and television broadcasting systems. Since joining the Laboratory's staff in 1963, he has been engaged in very long term planning. Mr. Thompson holds a quantity of patents in communications technology. He is a Director of a Music Publishing Company in Toronto, and is a member of the Association of Professional Engineers of Ontario and the Society for General Systems Research.

Tyas, J. P. I., M.Sc., M.I.E.E., P.E.—Mr. Tyas was born in Huddersfield in 1923. He attended Oxford University, E.T.H. Zurich University, the University of Gottingen and Manchester University where he graduated in 1950 with honours in Electrical Enginering and was awarded the Greatorix Post-Graduate Engineering Scholarship. He obtained a Master's degree for his research work on storage devices for computers in 1951. He held the position of Research Fellow in the Department of Physics at the University of British Columbia in 1951-1952 where he studied infra-red detector theory. Mr. Tyas has worked in the field of advanced radar techniques, correlation and storage devices in the United Kingdom and Canada. He built the first noise correlation radar in the U.K. in 1954 publishing several papers on the subject. He was Senior Design

Engineer in the Defence Research Board for the Canadian Alouette satellite. He was responsible for the first high altitude measurement of cosmic noise in 1960 by satellite. Mr. Tyas spent six years working in the operational research field at National Defence Headquarters on the military application of communication and surveillance satellites. He also studied the use of modern management techniques to defence research projects and is the author of a book on the application of Program Evaluation and Review Technique (PERT) and Critical Path Method (CPM) to management problems in industry. Mr. Tyas is a member of the Office of Science and Technology of the Department of Industry, Trade and Commerce, on whose behalf he attends meetings of the Scientific and Technical Information Policy Group of the Organization for Economic Co-operation and Development, and the ICSU/UNESCO Joint Project on the Communication of Scientific Information. He is a member of the Associate Committee on Scientific Information of the National Research Council of Canada. He has just completed a two-year assignment with the Science Secretariat, culminating in the Special Study No. 8, "Scientific and Technical Information in Canada", Part 1, which was published by the Science Council in April 1969.

SPECIAL SENATE COMMITTEE ON SCIENCE POLICY

Ottawa, Thursday, June 26, 1969

The Special Senate Committee on Science Policy met this day at 8 p.m.

Senator Maurice Lamontagne (Chairman) in the Chair.

The Chairman: This evening we have four different presentations: one from the Royal Architectural Institute of Canada, the second from Canadair, the third from Mr. Thompson, and the final one from Mr. Tyas and his group, who will be asked questions on this Special Study No. 8, entitled "Scientific and Technical Information in Canada".

As usual, gentlemen, we will ask you to speak for eight or ten minutes in turn, and then we will have a discussion period.

Will you commence, Dr. Howarth?

Dr. Thomas Howarth, Royal Architectural Institute of Canada: Thank you, sir. Do you wish me to give you a precis of my brief?

The Chairman: If you want to emphasize a point or a couple of points, or if you want to add anything at this stage, perhaps you would do so.

Dr. Howarth: May I ask you if the committee has seen the brief?

The Chairman: Yes, although perhaps not every member.

Senator Cameron: Who is the first witness?

The Chairman: this is Dr. Thomas Howarth from the University of Toronto.

Senator Cameron: He is not on this list at all.

The Chairman: No. This is a mistake that has been made.

Dr. Howarth: I think, Mr. Chairman, I will read through some extracts from the brief.

The Chairman: Yes.

Dr. Howarth: I said in my brief, sir, that the role of the architect in the modern world is expanding rapidly and is becoming more difficult to define with any degree of precision. As projects increase in size and complexity with the growth of urban populations, the boundaries between his traditional activity, that of building buildings and supervising the construction, and those of the allied professions and development agencies, are becoming increasingly blurred. If you think of the design, for example, of Place Ville Marie, or the Toronto Dominion Centre, each of these is an interdisciplinary exercise of great complexity: it involves not only metropolitan and city government and services, management and financial agencies, a mixed and varied clientele and a multiplicity of users, but it demands scientific, technical and professional competence of a very high order. Quite apart from the impact of an element of this size on the organizational fabric of the city—and by that we mean its services, its transportation and so on—its visual and esthetic qualities may affect fundamentally the character of a whole district, or indeed of the city itself. The example of Toronto is a very good one, where the whole scale of the city has been completely changed by the introduction of this one great building.

Now, we are concerned here primarily with the environmental aspects of architecture. We believe that there should be a very considerable extension of research and a very considerable extension of interdisciplinary input into work of this nature. We feel that it is significant that students of architecture now recognize their need for a better understanding of human response to the physical environment, and our students all over the continent are favouring electives in fields that vary considerably from the traditional ones. They are concerned with the humanities, the behavioural and social sciences, to a degree that was unknown ten or more years ago. These all relate to human factors in design, and this is the element we wish to emphasize. These studies may have, for example, the concern of everyday things in a domestic setting, or movement patterns of people at work and play, and the significance of street architec-

ture. I have just come here up the hill and seen some new telephone boxes, which presumably were passed by my Design Committee on the NCC when I was not there, because I am quite sure that, although they are beautifully designed, people are going to find them a little draughty in Ottawa's winter, although they are attractive things in the setting. These are the things our students are concerned with more and more, and also the squares and parks and important elements of that kind, and the functional, psychological and esthetic effects of what we now choose to call megastructures, these enormous building complexes of the kind you are going to see in Ottawa very soon, down at the Bank of Canada site.

Therefore, to a greater extent than ever before, the architect and indeed the student is encouraged now to concentrate on fundamental issues, to try to find those universal principles that will apply to most, if not all, design problems that he is likely to meet in professional life. So we are finding then that there is great emphasis on multi-disciplinary, multi-faceted problems which have human values and aspirations at their very core. These aspirations are loosely described now as "environmental". We are still searching for words. It is interesting to note too that the architect, per se, is finding himself faced by more and more difficult problems of an interdisciplinary nature, and it looks as though we are beginning to create a new kind of person, and we have not yet found a name for him. Names are being conjured from the air like "omnitect", which is particularly hideous, but it seems to go with "megastructures" somehow, to describe this universal person. You know, when was a universalist, and Leonardo was a universalist, but now it is very difficult indeed to contend with the terribly complex problems of the modern city, never mind the modern building. We are going through this period of great change, and the issues at stake are enormous. We are seeking your support for research on environmental problems on a rather large scale, and of a kind which certainly this country, or this continent has not seen before.

Perhaps I could just go from this, because questions will come later I think, to the recommendations that we have made, and I will add one or two footnotes to them. We have suggested in this brief that, as a matter of immediate urgency, a special committee should be set up by the federal government to investigate, with the collaboration of international professional bodies and the universities, the possibility of establishing an interdisciplinary program of environmental studies at the national level. You will notice the play of words again, "interdisciplinary" and "environmental", crop up again and again, and they are catch words at the moment, but we are still seeking better ones. Environmental studies become extremely complex: we are told that there is the environment of the space capsule, about which I will say more in a moment, and there is the environment of a room like this one.

It is recommended then that interdisciplinary task forces or work parties be formed as soon as possible to work on a regional, rather than a provincial basis, to advise the proposed special committee. You can visualize this structure, I think, quite clearly, with the special committee like this one sitting at the top, with a task force like you, constant task forces, drawn not from the provinces, we are suggesting, but from the regions, because we believe that the provincial context is not the one in which these great environmental and human problems should be considered, since it involves climate, geographical features and natural resources that transcend the artificial boundaries of the province.

It is recommended also that one of the responsibilities of the special committee and its task forces should be an assessment of the research potential of the universities of Canada, with a view to establishing a hierarchy of centres and sub-centres, where effective work in these fields should be done and new lines and methods of communication be developed without necessarily conforming to existing patterns. By this, sir, we simply mean that an assessment must be made, we feel, very soon, of the present contribution of the Canadian university and professional bodies, and their potential. If we could do this, if we could develop a framework, then it would be more easy to see where the weaknesses and strength of the framework lay, and where indeed it itself could be strengthened. In such a framework, of course, we would need a high degree of flexibility.

It is recommended that, notwithstanding the establishment of the special committee, ways and means be found of providing substantial financial resources for the development of interdisciplinary research in the environmental field. This, sir, as you know, is a common appeal, and we feel that probably the re-assessment of financial resources, especially the way in which they are allocated,

may be well worth while. I personally would add that in my experience the great lack at the moment is men and not money, but I feel that if we get the men, the money will come. However, sometimes it is very frustrating when you have the men and the money does not come. But by and large, the real need is for men of high quality who can work in these fields.

Finally we say that we would like you to recognize that architecture is really one of the basic disciplines relating to environmental studies. The architect's job is the creation of the physical environment, the buildings, the spaces, the various objects that go within the spaces, that make human places in which people can live and move. Therefore we suggest that the Royal Architectural Institute of Canada and the University Faculties and School of Architecture and Environmental Design be represented on your special committee and on such policy-forming bodies, work parties, task forces and research projects as may be established by the special committee.

This is respectfully presented, sir.

The Chairman: Thank you very much.

We have to-night, as you can imagine, quite a diversified group of guests. This is due to the fact that we are more or less now closing our public hearings, and it has been necessary to invite you all to-night, because there was no other time. Therefore I suppose that this will make our discussion a little more difficult than it has been usually, but I am sure it will be interesting just the same.

Now we are going to the movies with Mr. Ross.

Mr. R. J. Ross, (Chief Development Engineer, Canadair Limited): Mr. Chairman, honouraple senators: we welcome this opportunity to appear before your committee this evening and discuss the very important questions that you are concerned with relating to science policy. Unfortunately, we did not submit a written brief to you earlier on. We had participated in that submitted by the Air Industries Association, and we had relied on that. However, we would like to add some additional remarks to-night in an opening statement, and I will paraphrase these as best I can as I go along here. Towards the end of this statement, however, we would like to show you a movie, because we feel it bears very strongly on the things we have to say. This movie is related to a vertical take-off and landing aircraft, which was mentioned briefly during the Tuesday hearing.

Now, Canadair originated back in the 1920's, and it is a pioneer Canadian aircraft design and manufacturing company. It is located in Cartierville, Quebec, and employs some 8,000 people. It has produced something like 3,500 aircraft, both military and commercial, and it is engaged in the production of a wide variety of products, including aircraft, surveillance drone systems, off-road tracked vehicles and marine components. Sales have gone from a heavy orientation towards the Canadian Department of National Defence in the 1950's, to a sales mix which now includes some 68 per cent of erports in 1968.

We employ some 550 engineers and scientists, and we have a highly developed R. and D. capability.

The size of the company, although it is modest by U.S. standards, is one which appears to be well suited to the Canadian scene.

Since our inception, we have developed and produced a variety of aircraft and other products, and of some 15 aircraft types produced during the last 20 years, nine of them have achieved very significant export sales.

During the 1950s most of our development work was associated with extensive modifications of existing aircraft or aircraft designs to enable them to meet the Department of National Defence requirements. This work, however, involved all phases of product development, including design, test and manufacture, and through them we built up a competent and integrated development capability.

With its design and development capability well established we then embarked on a program of new product development to augment the production of modified aircraft, to build up our export sales and to achieve a balance of military and commercial sales. Our first effort in this field was the CL-41 basic jet trainer, which was our first completely original design. We started this in 1954 as a private venture. The aircraft was later purchased by the R.C.A.F., has entered service and is enjoying an excellent record.

Beyond this we have developed the CL-89 Surveillance Drone System. This was conceived by Canadair engineers to meet a battlefield surveillance need expressed by the Armies of Canada, the United Kingdom and NATO. The work leading up to the design was funded partly by the company with the

assistance of the Department of Industry. The full development program was authorized by the governments of Canada and the United Kingdom, and shortly afterwards the Federal Republic of Germany joined the program as a full partner. The development of the system has been completed successfully and is now in the early stages of production. I think the point here is that this is a very successful example of the multilateral international program where the needs of several countries have been satisfied at a reduced cost to each.

In the late 1950's we undertook the development of a light-weight tracked vehicle prototype for the Canadian Army. This vehicle was intended to operate over snow and rough terrain. As a result of this program we developed a capability, which we have since expanded further, and we have recently produced the CL-91 Dynatrac, unarmoured, high mobility tracked vehicle. This is aimed at the United States market. It was funded initially with company and Department of Industry funds, and it is now receiving U.S. Army funding. This vehicle is now reaching its final stages of type classification, and can meet the Canadian need, as well as the needs of other countries. This is what we believe to be a primary example of spinoff of ærospace capability into a non-ærospace product area.

Turning now to the area of vertical and short take-off aircraft, in 1956, after discussion with the Defence Research Board and the National Research Council, Canadair undertook initial studies of vertical take-off and landing aircraft in relation to future military and commercial requirements. It was concluded, as a result of this work and considerable discussion, that this class of aircraft would eventually play an important part in military support roles and in the solution of ther interurban transportation problem. In addition, it was likely that such aircraft could play an important part in the continued development of the Canadian north.

Canadair therefore embarked on a more research relating to ærodynamics, flying qualities, aircraft design studies and mission analyses. This work was done under a joint Defence Production.

As the work proceeded it soon became evident to us that if we were going to remain competitive in the field, we had to embark on the development of flying hardware, and in 1963 the CL-84 prototype program was launched with Canadair and the Department of Industry sharing the costs. The prototype first flew in 1965, and went straight into its flight development program. It completed over 300 flights, 150 transitions from vertical to horizontal flight, and you will see in the movie which we have a little later exactly what we mean by that.

As a result of this program the aircraft demonstrated its excellent flying qualities, and we believe completely proved the feasibility of this concept and the technology required. This viewpoint was endorsed by a United States Tri-Services team which flew the aircraft in a contracted evaluation program.

At the moment three improved versions of the aircraft are now under construction for an operational evaluation program by the Canadian Forces. At the same time, we are pursuing a continuing program of shared cost research and development to provide a series of improvements. We believe this program has been an outstanding Canadian technical achievement, and has demonstrated the technology of the tilt-wing V/STOL aircraft. In the process, it has absorbed a very large proportion of Canadair's total R and D resources. We have developed a leading position in the field, and this is, we believe, recognized internationally. However, having completed the first several steps in the innovation process successfully, we are now in a position where it is difficult for us to invest the further large amounts of money needed to exploit this lead.

The market for this type of aircraft has, perhaps, developed slowly due to many factors, but it is undoubtedly there, both to fill military needs and subsequently to help solve the interurban short-haul transport problem which is steadily becoming more acute.

In bringing such an aeroplane to the market place, the problems which must be solved are much broader than those which can be tackled by an aircraft manufacturer alone. In this situation Canada, if it wishes to pursue this opportunity, must, we believe, concern itself with all facets of the situation, namely, the overall transportation problem and overall transportation system requirements, safety requirements and regulations, operating procedures, air traffic control facilities and operational trials under typical operating conditions.

Turning very briefly to the question of supporting research and development, in order for a company to provide a broad base of new ideas and to maintain its competitive technical capability, it is necessary to conduct a continuous program of supporting research.

This work is exclusive of the main development programs which are pursued, and it is aimed at providing new and improved technology, the pursuit of good ideas and the development of new data so that each succeeding product will be an improvement on its predecessor. This work at the moment is largely carried out with company funds, with Defence Research Board support in specific areas. This work provides a base for research groups, groups of excellence, provides stability and continuity to research, and generates a flow of new ideas.

Now, we as a company have passed through a phase where we had the benefit of a large number of National Defence programs to generate capability and to maintain it in a competitive condition or situation. More recently this situation has declined very markedly, and we have turned to world markets and diversified where suitable opportunities have been identified.

In attacking the international market several factors have become apparent. As I said, we do not have a continued base of military R & D, which our competitors enjoy. Many of our competitors receive heavy government support of their new product development. This places a very real limit on the amount of company funds which we can invest in new product development because of low industry profitability, and hence in this situation the government shared cost assistance programs are of limited help.

Senator Grosart: Mr. Chairman, are we now getting the Canadair brief verbally?

The Chairman: No, but I understand we are now pretty well at the end.

Senator Grosart: I did not see the brief; that is all.

Mr. Ross: I am sorry. I must apologize for this, senator. We did not submit this written brief, but we felt we would like to take this opportunity to make these remarks.

Senator Grosart: Very well.

Mr. Ross: Finally, we would like to offer recommendations under two headings; one with respect to government assistance, and one with respect to national goals and directions. In the environment in which we find ourselves the present government assistance programs have been extremely helpful, but we realize that they are under review and we would like to offer the following suggestions:

That the amount of government assistance should be increased to permit the inclusion of most of the elements of the cost of new product development, and the repayment requirement should be modified to give industry the option of reinvesting such funds in further new product development.

We believe that the Industrial Research and Development Act should be reviewed to allow some of the "base period" expenditures, as well as "additional" expenditures.

Under national goals and directions, although it is extremely difficult to lay down plans for specific product development on a long term basis, since technology and the demands of the marketplace can change rapidly, we believe that even in these circumstances there are some directions which might well be established. We believe that Canada should maintain an independent capability to design and develop complete aircraft at a level of sophistication consistent with its resources. That we should participate, where appropriate, in the development and manufacture of more sophisticated equipment to meet Canadian needs. We believe that Canadian transportation needs, especially as they relate to the development of the north and to the solution of the interurban short-haul problem, should be studied on a nationally organized basis with the full participation of industry. The place of the V/STOL aircraft should be given proper consideration, since it offers the prospect of a major step forward. In the expectation that such transportation studies will show a future need for V/STOL aircraft, and in the light of the technological lead which Canada has already established in this field, it is recommended that the government give due consideration to the planning and implementation of a national effort aimed at realizing the full potential of V/STOL aircraft.

Mr. Chairman, we would like now to run a very short film, if we may, to illustrate to you some facets of the V/STOL aircraft.

(Showing of film followed)

The Chairman: Thank you, Mr. Ross.

Now we have something we probably need very much. We will hear from Mr. Thompson about regenerative planning.

Mr. Gordon B. Thompson: Thank you very much, sir. I come to you as a systems engineer. I am not quite sure what that is, after this morning's session. I think the more it is

defined the less effective it is. It is one who is engaged in studying communications environments, a subject that the architect seems to think is not part of environmental studies, but which I think is perhaps just as important as the subjects he was discussing. My concern is chiefly that the area in which I am working is what we might call a near science, and it would be a disaster, in my opinion, if, in setting out a science policy for Canada, in order to prevent abuse, the legislation, directives, planning, or policy, should suppress the development of new sciences. If you will, my concern could be put in one sentence. It is to do more things scientifically rather than to do more scientific things.

I do not wish to burden you with reading the brief. I have submitted copies. I would like to point out that, in my work with my employer, I have been fortunate enough to be able to use these techniques, which literally involve questioning very rigorously and very carefully the essential things that people are doing, and trying to design viable alternatives in order to be absolutely sure that, in our case, the communications future that we bring to Canada will in fact be a most meaningful one and one which will contribute to the kind of life that Dr. Timling and Dr. Burke were talking about this morning.

I think I would just like to rest at that point.

The Chairman: I am going to propose two alternatives to the members of the committee. My first alternative would be to stop there and have our discussion period with these three gentlemen, until about a quarter past nine, and then hear Mr. Tyas and his group, and have a discussion on this general subject afterwards. Would this be satisfactory?

Hon. Senators: Agreed.

Senator Grosart: Dr. Howarth, what is the present state of environmental research in what I can only call the architectural field, although you have indicated that is probably too limiting a name? I am not speaking of the whole environmental research in the colleges and so on, but what is the state in Canada? I have read your brief and you say that there is very little, and that anybody who was engaged in it a few years ago would be written out of the profession. But what has been done? Is there anything?

Dr. Howarth: I do not think I said exactly that, sir, but the position is that there is no research tradition in Canada, as I think I stated in my brief, and this is an advantage as well as a disadvantage, I suppose.

Senator Grosart: Excuse me, I was perhaps misquoting you, but you say that the student wishing to make a career in this field would normally be excluded from the professional register.

Dr. Howarth: Yes, that is quite so, because he would normally do a five-year undergraduate course—this is the tradition—course in architecture, and get his Bachelor of Architecture degree. He would then "normally" get professional experience and go into practice. In our province he needs three years for this. He may wish to go on for graduate work. If he did, at our school he would have two alternatives, one of doing individual research, or doing urban studies and research in the urban field. There were very few opportunities until quite recently for architects to work in the research field beyond that, but this situation, as I say in my brief, is changing and changing quickly. The reason, as I say, is not far too seek, because architecture, like other professionalism is an action discipline. In other words, we do things; we get things done—not always to the liking of our clients, but we get them done. This is rather different from the kind of profession where one is engaged in research, the results of which are not directly seen. So what we need desperately, I would suggest to you, is a great strengthening and a building-up, in fact, of a body of people who can help us in this whole environmental field.

Housing is a typical case. The reason why I was late to-night and have not been at your other sessions this week, is because I have just come from Chicago where we have been having our annual assembly with the Americans. Housing has been one of the things on the card, and it is quite obvious that a great deal is known about the way people live in houses, but very little has been done to bring that knowledge before the architects. In fact, the different professions that have been engaged in these areas are almost watertight professions, the sociologists and the psychologists, for instance, have been working away with the architects knowing little about them, and the planners, I suggest, are only beginning to learn.

So, what we are pleading for here is a recognition, first of all, that one of the prime concerns of all of us is this human environmental one. When we talk about these wonderful aircraft, you will notice that our friend

did not say anything about the noise from the plane, never mind its appearance, which made me shudder, but that, of course, is the first stage. In another ten years the plane will be reasonably handsome and probably silent. But, you see, in the whole aircraft field there are two major problems that we have been very well aware of, as architects and human beings. One is that we want the thing to do *that* instead of *that*, and we want it to be silent. If half the energy and money that the aircraft industry has devoted to making bigger aircraft was devoted to making silent aircraft, or quieter aircraft, then we would be a long way towards improving environment.

Senator Grosart: Of course, if you have lived in an Ottawa hotel recently, you might say the same thing about the construction industry.

Dr. Howarth: But, you see, the construction industry is not to blame, and I suppose the architects are not to blame; it is the people who are financing these things. When the costs are cut to the bone, as they often are now, then we cannot employ our know-how and skills in making it quiet. In this room do we need all this nonsense to light this room? I do not think we do. This is what I am talking about in regard to environment.

The Chairman: We will speak to the architect!

Dr. Howarth: No, you should speak to the lighting engineers, and the architect will get advice from them.

Senator Robichaud: It is a combination of both.

Dr. Howarth: Yes, it is a combination of both, but we are not communicating properly yet. This is why we are asking you to consider this whole problem of human environment as a major issue for Canada. I have been trying to get money—we are back to the money business—for some considerable time to finance a research group that we have had working on building in the north. I found that if I was studying plants or lichens or something in the north, I could get a grant. If I was studying whales or polar bears, I could get a grant. But my concern is with what happens to people who, in the future, are going to live in this hostile environment. What are their problems? How do we resolve these problems, and whether we can use that as a stepping stone for building on the moon, which is only the next step. These are hostile environments, just as the city is a very hostile environment.

Senator Grosart: My question was directed less to the future than to the present, because when a layman looks around and sees the National Arts Centre and the Toronto Dominion Bank building, and hears of plans already in hand for new satellite towns, he finds it hard to believe that there has not been a good deal of this kind of environmental sociological research already done. Therefore I was asking you: How much, and where is it? What does it look like?

Dr. Howarth: As I was trying to say before—and I am sorry if I got off the track, because I am very enthusiastic about this—the point is that a great deal has been done. However, the point I was trying to make was that it needs bringing together in reasonable form, so that there can be communication between the different disciplines involved. You mentioned new towns. We have just put up a project to CMHC—and had it turned down incidentally—for a major study of rapid urban development. Now, nobody has ever done this before. In the U.K. alone there are 12 new cities now on the drawing board or under construction. Twenty-three new towns have been built or are building, and there is a vast quantity of information we know, but it has never ever been brought together.

Senator Grosart: Have you talked to Canadair about the inter-urban transport problem?

Dr. Howarth: I do not feel I am really answering your question, except to say that a great deal of work has been done in different areas, but it needs pulling together. The architects so far have not made a notable contribution in this country—elsewhere they have—and that is our fault, because of the type of profession. I think we have been geared too much for too long towards the creation of the individual building. In the last five years this has changed quite rapidly, and this again is part and parcel of our changing society.

The Chairman: Why was your proposal rejected?

Dr. Howarth: Must I answer that question, sir?

The Chairman: No.

Senator Grosart: My next question was in that same area.

The Chairman: It was not lack of money?

Dr. Howarth: I do not know. I would not think so.

Senator Grosart: To what extent has the architectural profession been getting help from CMHC in research in this area?

Dr. Howarth: It is getting a great deal of help. CMHC I think has been extremely generous. The schools of architecture are getting help in the way of grants to assist in graduate work, and a great deal of money has been poured out by CMHC in all kinds of areas for work in research, particularly in the housing field and in the planning field.

Senator Grosart: The Chairman, in some of his extramural speeches, has drawn attention to the fact that the Department of Agriculture funds research in that area to the extent of $90 million, and the total in urbanization research is, I think you said, $2 million to $3 million.

The Chairman: In the last 14 years. These are not my figures.

Senator Grosart: No, I said you have drawn attention to that.

Dr. Howarth: Senator, I wonder if I could change the direction of this a little. The quality of research and the effectiveness of research is not measured in dollars, and I would suggest—

Senator Grosart: I think you are the first person that ever said that to us!

The Chairman: But he still wants more money.

Dr. Howarth: Yes, but I believe it is true. I am talking about the quality of research and its effectiveness. I do not know whether it is in order to talk about CMHC? I do not know whether there are CMHC people here.

The Chairman: They will read it, anyway.

Dr. Howarth: Perhaps I had better not say. I was going to say that I think there has been a great deal of merit in directing funds into the housing area, say, or the planning area, but what is needed, we believe, is some form of coordination, even within CMHC, if they will forgive me. A great deal of information comes into CMHC, but how that is disseminated to the profession effectively, or how it affects the development and central planning of Ottawa, or the new proposals for Hull, I do not know. It is this communications business. I think we have been going through a period when we have been accumulating quite a lot of information. Now it needs sifting and assessing. We need to study how to make it accessible to the architect and planner, and I do not think we have even begun to resolve that problem. It is a matter not only of information retrieval, but of communication.

Senator Grosart: We read of these endless discussions between municipal planning boards. How much input into the decision-making at these levels is there of the results of research, of environmental research? Are they working in the dark? It certainly looks like it when you read the accounts in the papers of any city council discussion of the route of a subway, or slum clearance, for instance.

Dr. Howarth: Well, I would say that many decisions are made without adequate information. In the Ottawa central area this advisory design committee of the NCC, which I happen to chair, urged very strongly that a consultant be appointed to deal with the central area. This we found was acceptable, and, of course, others had been thinking the same, and we got that. Now we have a plan for the central area of Ottawa, but, you see, we can go just so far; we cannot at the moment carry the politicians with us, and the financiers, because, in the last analysis—and this is also in my brief—I think the really important thing here is: who are the decision-makers? I challenge you to tell me in the case of central Ottawa who are the decision-makers, and what is the ploy? What are the forces that play on them? You see, this is in here, because we believe that the politicians, the decision-makers, have to be brought into this somewhere. We have to know where the lines are before we can work effectively.

Senator Grosart: Of course this is the whole problem of a national science policy. In answer to your question, I get the impression that the decision-makers here are the newspapers.

The Chairman: This is not going to help you very much.

Senator Grosart: And the T.V. stations. To what extent then are the traditional academic disciplinary divisions a limiting factor in this new interdisciplinary context that you are talking about?

Dr. Howarth: The divisions are breaking down everywhere, of course, in all kinds of ways. I can illustrate that very clearly by what is going on in my own school. Two or three years ago we were doing what most other schools were doing, a sequence of design programs, where the students would design housing in the second year, houses and little banks and so on, and we would work through in that way. Now we have completely restructured our program and we do one thing in the whole year, but we bring into play during that year all kinds of other disciplines, including sociology, engineering, and economics. In other words, we are tapping many sources that we were not tapping, and we are tapping them in a different way than we were doing a few years ago.

The student to-day is a very different kind of person from what he was a few years ago. He is much more intelligent I think; he is much more critical, as you well know. We must not get into the student problem, but my suggestion is that the staff program, or teaching problem, is as great, if not greater than the student problem. We are back again to this factor of finding the right people for the right job.

So it is a difficult question to answer, but whether or not the public information media are the decision-makers, I do not know. I think they are taste-makers or taste-breakers, and one of the saddest things, I think, that is happening to us now in North America, is the way in which our standards are being downgraded and taste is being ruined by...

Senator Grosart: We are listening.

The Chairman: I am still thinking about this architect here. I suppose you wanted to say the politicians?

Senator Robichaud: Is it not a natural and common trend? There is competition among all architects, as we all know. Every one is trying to outdo the other, and, as a result, they are producing designs for more attractive—in some instances, maybe not attractive to all people—and definitely more expensive buildings. Is it not a trend? Is it not general? Take my own province of New Brunswick, for example. There are two or three firms of architects every year trying to outdo one another in building a more attractive and more expensive school. There is a poor province building multi-million-dollar schools today. Is not that a fact?

Dr. Howarth: I would disagree with you. I think you have to recognize that there are other things than the cost of building.

Senator Robichaud: Yes, I know. I do not say that I believe in this myself. I am not expressing my own views; I am expressing views that we hear from the general public.

Dr. Howarth: The general public is an amorphous and rather variable creature. I would say this, that architects by and large are not competing with one another to produce more attractive designs, as you say. I think what they are doing, or what they are trying to do, is to compete with conditions. They have problems. They have problems presented by the society or school, or whatever it is, and they have an economic problem. They have to work within-a budget, and naturally they want the thing to be an improvement, to enhance the surroundings.

Senator Robichaud: I like this expression that they have to keep within a budget. Do they define their budget? Or is it not the builder, or the province in this case, which has to meet the architect's budget?

Dr. Howarth: We are getting into difficult waters here. I will go on as long as you like on this. I think the point is really this. I am very much involved in university building, and I know what you mean. There is a budget that we have to try and meet, and I can assure you that any architect worth his salt is trying to work within that budget. He is trying his best to provide you with the kind of conditions and environment you need. Again, if he is an architect really worth his salt he is trying to bring to bear-on your problem the very latest know-how in that particular field, the most up-to-date information that he can get.

Senator Robichaud: Is this not difficult for the general public to believe now, after the experience of the National Arts Centre?

The Chairman: I will not tolerate any questions on that.

Dr. Howarth: I would be very pleased to meet anyone who wishes to talk about that afterwards.

Senator Carter: May I ask this question: Is there anything distinctively Canadian emerging in Canadian architecture—anything that relates to the Canadian environment rather than to other environments?

Dr. Howarth: That is a good question, because this is not a question that worries me at all.

The Chairman: That is a new definition of a good question.

Dr. Howarth: Well, it is a good question, whether it worries me or not, Mr. Chairman. I think it is a question that should concern all of us. It is like saying: Is there a Canadian school of painting emerging, or a Canadian school of music? Quite frankly, I do not think this should concern us, because we cannot tell; we are too near to it. The important thing is whether the work is good, whether it will stand criticism, and what is the quality of the work. It does not matter whether it is Canadian or not. When we gain perspective in the next 50 years—some of us do, some do not—the test of history will be whether people can look at the 1960's and 1970's and say: Here was the great watershed in Canadian architecture or art, and from then on Canadian architecture emerges. Of course, there is a Canadian architecture, if you ignore many of the glass boxes and things that are going up, which are universal. But we cannot start by saying, "I am going to design a building in the Canadian style", because there is not one; any more than you can say you are going to design it in the German, French or Italian style. You see, where we have gone wrong so far and so often, I think, is that we have tried to copy, as you were suggesting, sir, work that is done elsewhere. We look at the shell rather than let the thing grow out of the climate, the geography, and the people. Architects are now learning this very quickly. The Canadian climate, the Ottawa climate, it is one of the most difficult in the world to deal with.

Senator Carter: At one time architects were preoccupied with copying the Grecian style or the Roman style, and then, as I understand it, there was a swing to functionalism, so that you put your stress on the function of the building and on simplicity. Where are we now? Are we now in space, or somewhere in between?

Dr. Howarth: May I say that architects never tried to copy they adapted. The Capitol in Washington is not a copy of St. Paul's or St. Peter's; it is a new and gorgeous thing. The same can be said of the Lincoln Memorial and its superb Greek Doric columns, but it is not the Parthenon; this is North American early 20th century Greek.

Senator Carter: You can go out here in the suburbs, and you see new churches going up, but they do not look like churches any more; they look like mosques. They remind you of something that was created perhaps a thousand years ago. We have come back to build a similar pattern in a different material or different setting, but the basic outline is pretty much the same.

Dr. Howarth: May I ask a question, sir? What is a church?

Senator Carter: Well, ...

Dr. Howarth: You see, there is no answer to that, because a church is a different thing to different people. The church *per se*, is going through a very bad time; it is going this way and that. I do not know whether it is a question of the pill, the Pope, or procrastination, but it is going through a bad time. There is no clear way.

The Chairman: Do you think it is worse than Parliament and the politicians?

Dr. Howarth: No, the church is getting the buildings it deserves. But, you see, these questions go back to the roots. This is why I say this is very interesting, because we are living in changing times, where standards all the way down have been fragmented. I am not depressed about this at all; I cannot be, because I work with students. We are building for tomorrow. The thing is that out of this, I am absolutely convinced, there are going to come new sets of rules and standards. The principles will not change, and I am very optimistic. Take Ottawa-Hull: it is a really beautiful place and this is man-made. This is Canada emerging. Watch very carefully the Bank of Canada project, and see what comes out of that. Here there is a great opportunity to show how to develop an urban complex in an intelligent way for today's living.

Senator Carter: It will be the first one I have seen change, because they all look alike.

Senator Cameron: My feeling and observation is that many of the small churches in Canada and in Germany and in other places are the most exciting kind of architecture in any phase of the construction industry. There is a film on German churches built since the war. It is a magnificent thing, and it deals with these small churches. You can go to California, Arizona, and throughout the

country, and you will notice that the small churches contain the most exciting aspects of construction or architectural design today.

The Chairman: I think we could go on almost all night discussing architecture.

Dr. Howarth: Yes, but may I say that there is a very important thing coming out of this. You have used the word "exciting" several times, and it is time that architects and others got this out of their systems, because really in the environment—and I must come back to this—you cannot stake too much on excitement. What we really need is a very good sort of new tradition, if you like of building, so that all our builders, constructors, and developers can establish some kind of first principle on which to work. It is an 18th century idea, where everybody seemed to have this peculiar sense of right building, whether he was a speculative builder or whatever. What we need is good background building. We can produce all the excitement you want, but it seems to me that in housing certainly, and in many other areas in the urban areas, we should not be excited all the time. The exciting church can be a jewel in a setting, but the problem now is that the setting is as exciting as the jewel, and the value of the jewel is downgraded.

The Chairman: It would certainly increase the rate of renewal in the Senate if we were always excited.

Senator Cameron: Mr. Chairman, there are two very important points here, and one on which I would like to have the witness's ideas is the basis of payment for architects. As one who has been a victim of this, I say the architect has a built-in incentive to get the cost as high as possible, because he gets a percentage of the contract price. I know there are decent and conscientious architects, but the net effect is always that the cost is as high as possible. You say that you work to budgets. I know of $20 million buildings that are up to $30 million, and this is following the architect's planning, on university complexes today.

Senator Robichaud: And in schools.

Senator Cameron: And in schools and everywhere else, and the architect is getting a percentage of the cost.

Dr. Howarth: Mr. Chairman, I am here as a witness, and I assume I am a witness for the defence.

Senator Cameron: Well, you are.

Dr. Howarth: As I said, I am perfectly willing to meet you on any of these points at any time. Whether this is the time and the place, I do not know.

The Chairman: No.

Dr. Howarth: But I would not like to get into this. I was not expecting this kind of thing, not that that matters, but in answering this and talking about churches, I do not want to be using time that I should be using to try and convince this committee about something which is absolutely fundamental to the well-being of Canadians in the future, and this has nothing to do with architects' fees.

Senator Cameron: This leads me to the second question. The Toronto Dominion complex has implications of tremendous scope and scale for living in the future.

Dr. Howarth: Yes.

Senator Cameron: What research has been done, or what needs to be done, to find out how people are going to adapt to these hundred-storey buildings which are coming, because it involves transportation, it involves the claustrophobia of 20,000 people living in a building. I believe that in the Pentagon in Washington, which is not a high building, 34,000 people work. This provides tremendous problems of the movement of people. What is being done about it?

Dr. Howarth: Mr. Chairman, this is precisely the key point in this brief. We do not know, and we want to know, and we need to know, and we have to know. Unless we do we will go on making mistakes. You see, these are really financial gimmicks—the Press will love that, but they are. There is a plot of land that somebody wants to develop, whether for a bank or a small-scale development. The owner of the land decides, within certain constraints, that he can build on it. The key thing to us is that when you put up a Toronto Dominion Centre the flow of people out of it into the streets becomes fantastic; the parking situation becomes complicated; the servicing of the city itself becomes complicated. What is not really known is precisely what the long-term effects are.

You can move over from that into housing, which is again one of our major issues. If you

look at Toronto or Montreal or any of the big cities, people are now being forced to live in high-rise buildings. What we do not know—we can only suspect, because we have not done the research—is what the effect is going to be on the next succeeding generations who are brought up in this kind of environment. The family loses one of its important assets when it moves into a high-rise apartment; it loses open space, and the ability for children to go out and play.

The Chairman: And for cats.

Dr. Howarth: Now, is there a way by which we can concentrate people in the cities and give them all the amenities of the city, such as the theatre? You know, you will forget all about the $46 million in another few years, because it is such a gorgeous thing. Is there a way in which we can design these high concentrations of people and still maintain the open spaces and so on? We do not know yet. We believe that we are on the way, but this is why we need research.

Senator Belisle: I noticed that Dr. Howarth was very careful in not answering as to the percentage, but would he give me an opinion on this: If the percentage fee had not been there would Habitat, at Expo 1967—which was very exciting when it first came out, but which is not too practical now—have been of the same design?

Dr. Howarth: Oh, yes. Do not forget that Habitat was designed as a fifth year thesis project by an undergraduate student at McGill University. That is where Habitat started. It was a bright student who designed this as his thesis project, and he had the rare and marvellous opportunity a year or two later of actually putting these ideas into practice. As he designed and conceived it originally, it was a very economical thing, but you had to put up something like a thousand apartments to make them pay, because of the cost of the machinery and the techniques. It was exploratory. I do not think this question is fair, because nobody asks what it cost to put up the first Sputnik, but until you put up a Sputnik, you cannot send an Apollo around the moon. All these things inter-relate. You might say it is a waste of time sending Apollos around the moon or building Habitats, but Habitat was an experiment, and we have not assessed it yet; we do not know. There were a lot of mistakes in Habitat, but they were not intentional mistakes. We learned a lot from it, and the lessons of Habitat are going to be carried on for years and years. We are now talking about plug-in apartments and plug-in cities—these are not new—where you buy your house out of the catalogue and it is plugged into a frame and it hangs there, and when you want a bigger one you take it out and put in another one. This is the kind of thinking that is engendered by Habitat.

The great excitement about Sputnik and Apollo for me is that there is a completely controlled environment, and if we can only take the lessons from that and give our houses a little package that can deal with the sewage and the water and everything, we can do away with sewers and water supplies in cities. The savings would be fantastic. This is the feed-back to us as planners and architects from Sputnik.

Senator Cameron: I am glad Dr. Howarth used the word "exciting" two or three times.

Dr. Howarth: Just one other word, sir. In the brief, when we are considering environment, I want to stress that we must not be misled into thinking always of the city, as we tend to do, in housing, because some of us are very concerned indeed about the larger environment, the countryside, the parks and the wilderness areas. What is happening in Algonquin Park? Who are the decision-makers there, and how do we control the decision-makers to the point where the decisions are taken in terms of environment and not in terms of immediate expediency, whether it is timber, coal, or water power?

Senator Grosart: I have one question for Canadair: How significant is Canada's technological lead in the vertical take-off aircraft?

Mr. Ross: I think, senator, that the best way to answer that question for you is to say that a lot of people have attempted to achieve a satisfactory development of a vertical take-off aircraft. I believe there were probably something like a dozen different projects—mostly in the United States, one in Canada, probably several in the United Kingdom and one in France. I think of all these possibly two or three at the most have been successful in terms of the characteristics that they have been able to demonstrate as to the feasibility of the concepts that were involved. I think our CL-84 is one, and there is probably one British and one German that have achieved similar types of success. But the concept that we have pursued is the one which we believe is most appropriate to the short-haul transportation situation, and many military roles.

Incidentally, it is one which the United States Air Force has identified as the one they want to pursue first in the way of military support transport. Therefore, if we take together the type of concept we have picked out for ourselves, and the stage of development that we have taken it to, I think it can be said that we have virtually a unique technological lead at this point. Nobody else has taken this concept and reached the point that we have with it.

Sentor Grosart: To what extent is it protected from imitative processes by other companies? I ask this question because it is a very important one in respect to government funding at the innovation stage.

Mr. Ross: The difficulty that I believe we all face in the world of patents is that it is extremely difficult to patent an idea, and invariably one is forced to attempt to patent something which is reduced to design practice. Once you reduce a thing to design practice then it is relatively easy for somebody else to come along and sort of take it and run around you and produce something similar but not quite the same, sufficiently different that it would obviate a patent. It is extremely difficult to get a patent in the first place; it is not all that difficult to find one's way around a patent, so that the thing one has to do is, when one has a good idea, to move fast to take advantage of it.

Senator Grosart: So your main protection is really . . .

Mr. Ross: Is to move.

Senator Grosart: . . .early innovation in the market?

Mr. Ross: Yes.

Senator Carter: May I continue with that, because I thought you said earlier that you will have a new version of this machine, but it is difficult to carry your innovation to completion without some assistance from government.

Mr. Ross: Yes.

Senator Carter: How far away are you from completing this?

Mr. Ross: I should say first of all, senator, that if you were to look at the picture you just saw, and then you were to look at the actual machine that is about to enter its flight stage, you would not recognize a great deal of difference between them. The differences are mainly internal in some of the systems.

Senator Carter: What do you mean by "improved performance"?

Mr. Ross: Improved capability, and more reliability.

Senator Carter: What advantages does this type of machine have over helicopters, which are also used for military support, ground support, and so on?

Mr. Ross: The fundamental difference is that this machine is high-speed. Once it has completed its vertical ascent, its wing is tilted down, and then it is a high-speed machine. It is like a normal aeroplane.

Senator Carter: It can rise from the ground as fast as a helicopter?

Mr. Ross: Oh, yes, and it can control itself just as easily as a helicopter can in all directions, but it has much higher productivity than a helicopter because it is so much faster.

Senator Cameron: What would the operating costs per hour be, roughly?

Senator Robichaud: Compared to similar planes?

Mr. Ross: I think I am going to have to turn to our vertical take-off program manager on this one. If I remember the results of the study we did of, I think, a typical 40-passenger machine, they showed that if you looked at the operating costs versus the distance over which it is operating, then it became cheaper than the helicopter over about 25 miles distance, and as you proceeded on out, so it then very rapidly approached the conventional aircraft in its operating costs. So although I cannot give you an actual number, perhaps it gives a relative measure of the situation.

Senator Grosart: But you would have a lot of other environmental pluses, such as the solution of the airport runway problem; so that mere cost would not be the whole story.

The Chairman: To come back to the point which was raised a moment ago, what about the noise?

Mr. Ross: Well, unfortunately, people collect together in cities, and then they want to move to other cities. Commerce has to go on, and it wants to be transported. Goods have to be transported from one city to another.

Although people were there first, before the means of transportation, nevertheless there is this interaction which goes on all the time between airports, people, and transportation systems. One often hears complaints from people who live near airports that were there long before the people arrived there, so maybe what we really need is a little more systems analysis, shall we say, or study and evaluation of all these things as a whole, to make sure that our vehicles are compatible with the systems within which they are operating. Now, vertical take-off aircraft certainly produce noise; they are no less noisy than other aeroplanes, and I believe this is an area where research might well be done.

Senator Carter: What about the lifting capacity, as compared with that of helicopters? Could you lift a jeep and carry it with one of these?

Mr. Ross: Oh yes. As our movie showed, when the aeroplane operates in the purely vertical mode it has a particular weight-lifting capability. If it tilts the wing down to a very small angle it can take off in maybe three fuselage lengths, and it can just about double the weight it can lift off the ground. Now, that particular aeroplane which you saw, I think, can lift something of the order of 3,000 pounds vertically. Is that right, Mr. Phillips?

Mr. F. C. Phillips, Program Manager, Canadair Limited: About 4,000 pounds, yes.

Mr. Ross: 4,000 pounds, and its all-up weight is something like 13,000 pounds?

Mr. Phillips: 12,000 or 13,000 pounds. For a short haul the payload is about two tons.

Senator Carter: Are you developing a capability to sort of make a flying crate out of it in industry?

Mr. Ross: One of the features that we have to put into this aeroplane that is being evaluated by the Armed Forces is the ability to put a sling underneath and lift small vehicles and packages. In that sense it would be operating as a crane.

Senator Carter: But I was thinking about construction work. Can you carry materials of sufficient weight to sufficient distances to eliminate the need for building roads and tracks to get the materials there?

Mr. Ross: Yes. I think, like all things, you would have to look at the relative cost of the options open to you, but certainly it could do that.

Senator Carter: Well, it would do it cheaper than helicopters, apparently, over longer distances.

Mr. Ross: Again, when the distance is very short, then perhaps the helicopter is more effective; but once you have a distance involved then this sort of aeroplane does become more effective.

Mr. Phillips: I manage the V/STOL program at Canadair. The senator's question related to the carriage of cargo as a crane over distances. Over a short distance we can certainly do this, perhaps not so effectively as the pure crane helicopter, which is designed for that purpose and virtually none else, but an aircraft of this sort can travel a good distance at quite a good speed carrying a fair load, and the productivity of the transportation is high. The ton-miles of transportation that it can carry is very competitive with the conventional aircraft, so that you can operate into the north, for example, over large distances where there are no roads and not even airports, and can operate effectively with oil-drilling equipment and this sort of thing, into very remote areas, despite the fact that these areas are quite distant from population centres.

Senator Carter: Can you operate this type of machine in snow and ice with skis?

Mr. Phillips: Yes, we have done this with the prototype aircraft. It did not show in this particular movie, but we have flown in light snow, hovering and so on with no particular problem.

The Chairman: I am sure that we could go on, sir. We have been interviewing quite a number of, perhaps not your competitors, but collaborators, as you will remember, from when you were previously before this committee. We have asked all kinds of questions about government incentive programs. We could ask you the same question, but we would probably get the same answers.

Mr. Ross: I hope so.

Senator Grosart: We will ask Mr. Tyas.

The Chairman: I would like to ask a final question of you. Do you work in close co-operation with the Institute of Urban and Regional Research? Is this the right name?

Senator Grosart: Yes, it is "Urban and Regional", and they told us they did not do much regional research.

Dr. Howarth: Would it be in order if I asked Alan Armstrong to enlarge a little on what I have tried to say about research in this field. I think he is better informed than I am on this matter.

The Chairman: Are the architects working in close association with that Institute?

Dr. Howarth: Yes, they are.

The Chairman: That is my only question.

Dr. Howarth: I hope Mr. Armstrong will support that.

Mr. Alan Armstrong: Yes, Mr. Chairman. Three members of Dr. Howarth's faculty are members of the council. I think it is that close.

The Chairman: Thank you very much.

Senator Cameron: Some universities have set up faculties for divisions of environmental studies. The University of Montreal has one, and the University of Calgary has one. Are the architects working with these to get this multidisciplinary approach that is so necessary?

Dr. Howarth: Yes, I would say so, except in Calgary. There is not a school of architecture in Alberta yet.

Senator Cameron: There is an argument going on.

Dr. Howarth: Yes, there is an argument that has been going on for several years as to whether it should be in Calgary or Edmonton. It has been vacillating between the two, and I believe it is going to be in Calgary. At the University of Manitoba they changed to a Faculty of Environmental Design some years ago. We tried to do that in 1967, but there was some opposition from professional groups, so as an intermediate stage we called it the Faculty of Architecture, Urban and Regional Planning and Landscaping Architecture. We have the three actual professions, if you like, and we are very closely linked with the engineers, of course. We are now at this very interesting stage where we need more departments to build this up into a really strong environmental group.

The Chairman: Thank you very much, gentlemen. If you want to stay with us to discuss the problem of information, you are very welcome to do so.

Mr. J. P. I. Tyas, Office of Science and Technology, Department of Industry, Trade and Commerce: Mr. Chairman and honourable senators, I would like to present some views on an additional and essential element of science policy, scientific and technical information policy, which in recent years has been of growing importance to all elements in our social, economic and scientific environment.

Scientific and technical information is not the sole prerogative of any one agency or department, but rather cuts across the whole fabric of our society. For this reason, the study on Scientific and Technical Information in Canada was carried out by a special study group of the Science Secretariat. The terms of reference of the study group related to scientific and technical information, but the recommendations applied to problems in many other fields.

The study group was divided into eight sub-groups. Its members represented industry, government, and university sectors, and were from all regions of Canada, from the east coast, the Maritimes, to the west coast. Today we have present four of our sub-group chairmen: on my right, Dr. Hunt, industry sub-group chairman; then M. Forget from Laval University, the university sub-group chairman; then Mr. H. C. Campbell of our Techniques and Sources Sub-group from the Toronto Public Libraries; and, on my far right, Dr. von Baeyer of the economics sub-group.

Mr. Chairman, in your examination of science it was possibly invoked because of the increasing expenditures, and I think this leads directly to a need for allocating priorities in science and a more balanced allocation of resources between science and other areas contributing to our national well-being. No country can research in all the fields of its interest; big research has to be left to the larger countries. The generation and transfer of knowledge are interdependent and should work with equal importance in stimulating economic growth. Canada needs sound systems, services and transfer techniques to ensure it is gleaning the most from the world-wide wealth of new ideas and experience. The study growth has found there are insufficient mechanisms in Canada to ensure that the results of the scientific effort in Canada and in the world are available for the benefit

of any Canadian users. And we have wondered why all this research is supported, why all this money is spent, when the product is only too often locked in the files and libraries of our industries, governments and universities. There is a need to ensure that new technology and experience are transferred to those who might benefit and utilize it the most.

Canada performs less than three per cent of the total research and development done in the world to-day. The results of all this research and development provide a base for future progress. The one way in which this base is accessible is in the publications reporting these R & D results.

The problem facing us in this area is, then, one of increasingly large numbers of primary publications, as many as two million a year. These articles appear in some 26,000 journals, besides which there are some 30,000 scientific books published each year. There is a corresponding increase in the number of secondary publications. This is a further magnification of the problem and there is a large number of extra users, which are doubling every 15 years, and this has been happening since the 18th century.

This is also an international problem. No one country can afford to do all the R & D that is required; likewise, no one country can be self-sufficient in providing all the elements for its required information services. Therefore, countries are working together in this area to benefit from each other's experience and to co-ordinate their future plans in hopes of avoiding the unnecessary expense from the duplication of effort.

But this problem goes well beyond the storing and dissemination of this ever-growing bulk in libraries using traditional interlibrary loans. We now have the conceptual basis and the technological competence to place all of this new information at the feet of the technologists in industry or managers needing up-to-date economic data, and also to interpret this information in different levels for different users.

It is essential to create an environment which is conducive to innovation and growth in business and industry. Our national prosperity and our standard of living both depend on the vigorous and competitive production of materials, goods and services.

In considering the contribution that scientific and technical information should make, we have concluded that effective information services are essential in Canada for two reasons:

(1) by providing appropriate information and data at the required time they facilitate the making of policy and management decisions in all sectors and on the balanced use of resources and priorities;

(2) by keeping management, scientific experts and technologists aware of domestic and foreign new ideas, technology and developments, they act as a spur to invention, innovation and exploitation.

When available knowledge is used by industry to provide a product or service which can be marketed, or by a university to plan research, then a real economic benefit accrues from existing information resources and services. We suggest that it is most important that our information resources should be so organized that they are accessible to all sectors at the right intellectual level. This goes beyond using new technology to speed up the traditional dissemination of documents. It leads to new concepts in the information field, data retrieval, selective dissemination of information, information analysis centres, and the transfer of technology and experience.

Some Canadian libraries and information centres are trying to meet these needs. The efforts are many, diffuse and isolated. The duplication of effort is costly and will become more so. Direction is needed and only the federal government is in a position to give the necessary impetus, to act as a catalyst through organizing a suitable focal point for these diverse activities.

Canada to-day has no focal point to co-ordinate the national effort. Canada has no effective scientific and technical information policy to-day. We suggest that one prime objective of Canadian science policy should be to establish such an information policy in order that Canadian users be provided with scientific and technical information resources second to none; in order that the world-wide R & D effort can be fully utilized and exploited by Canadian industry, universities and governments to aid all of the Canadian economy. We suggest that a Canadian science policy must establish a mechanism for a balanced allocation of resources between our future R & D effort and the utilization and exploitation of the results of all R & D effort in Canada and in other countries. Criteria must be established to set an economical level for

Canadian R & D and to optimize the use of the international knowledge resource.

Internationally, in Paris, in March of 1968, the OECD Ministerial Meeting considered scientific and technical information as one of its main topics, and the secretary-general, Mr. Thorkil Kristensen, set up a high level ad hoc group with Canadian represen'ation to conduct an in'ensive one-year study into scientific information policy. In addition, the permanent Scientific and Technical Information Policy Group will be reviewing the information policy of individual countries in much the same way as OECD has conducted its national science policy confrontations. Canada will be the first to be so examined, and yet Canada does not have a co-ordinating agency to act as a focal point to which the OECD group can address itself.

The focal point that the OECD has recommended each country establish, is not a library but an agency capable of assessing the importance of the scientific information infrastructure to the social, economic and scientific goals of the country and determining how individual information services, systems and agencies should work together to assist to develop these national goals.

Recently the United States has set up a special office, a Commission on Information Science and Libraries, a high level co-ordinating body to advise the President, Congress, and related agencies and professions on information developments. It also has a committee on Scientific Technical Information, which is located in the office of Science and Technology. It has set up a separate committee on Scientific and Technical Communication to co-ordinate the government and private enterprise groups in this field.

In the Department of Education and Science in the United Kingdom, an Under-Secretary for Libraries and Information was appointed in April, and this elevated the head of the Office for Scientific and Technical Information to Deputy Minister level.

In February of this year, the Prime Minister of France set up a National Committee on Scientific and Technical Documentation to advise the French Government on information policy and to overview the French situation.

I think today in Canada, as an interim measure, it is necessary to utilize new technology in the field of data handling, communications and computers to assist in automating our present library functions and improve our distribution services. In addition we must move into more advanced information and data handling processes such as on-line data banks, selective dissemination of information and mission-oriented information services especially for interdisciplinary studies in universities, government and for specific sectors of industry.

The transfer of technology and experience to and between industries must be facilitated by setting up local and regional technology transfer centres where specialists can assist industry.

Finally, agencies and institutes with special know-how must be encouraged to set up Information Analysis Centres to evaluate, review and interpret the information and data they handle for the benefit of other users.

We have also recommended the establishment of a Referral Centre to act as a clearing house for on-going R and D, who is doing what, the location of information centres and information services. In this way, policy-makers will have the information required to plan priorities, managers will have the data required to guide particular industrial, university and governmental programs, and any user will be able to consult the "yellow pages" of information, and thus be directed to sources most capable of meeting his needs.

Mr. Chairman and honourable senators, inevitably industrial nations are gradually moving into the age of knowledge utilization. More and more people are earning their living by generating, manipulating, interpreting or utilizing information in many fields, including those of the social sciences, economics, statistics, technology and science.

We suggest that the nations who expand their economies most rapidly to become the advanced nations in the 1980's and beyond, will be those that harness mankind's collective experience by means of effective knowledge policies and the efficient management of knowledge systems aand services.

To translate the words of Monsieur Galley, the former French Minister for Science, "Any nation without an automated information service by 1975 will be fifth rate".

Thank you, Mr. Chairman. My colleagues may be pleased to answer some of the questions.

The Chairman: I am sure that Senator Cameron is entitled to initiate the discussion on this one.

Senator Cameron: Mr. Chairman, I am delighted with the thrust of this discussion.

Now, we have asked, as a committee, from time to time that, in order to get an overview of what is going on in Canada, we should have a national inventory of research and development, and we have been told that it is impossible; that there is so much that it would just be impossible to tackle it. You said, I think, that there were 30,000 scientific books published each year, and 26,000 scientific journals. Is that correct? Then there was another figure of three million that you used.

Mr. Tyas: Two million documents or articles.

Senator Cameron: Two million?

Mr. Tyas: Yes, approximately.

Senator Cameron: I think these are the kinds of figures that frighten people away. But, in this day and generation, with the proper use of the computer, I am sure we can do it. I do not know how; that is your job. You have recommended in chapter 5 forging a knowledge network, which in effect is setting up an over-view of everything that is going on. I am wondering if you have by any chance been down to the Stragegic Air Command at Omaha, Nebraska?

Mr. Tyas: No, I have not been there, sir.

Senator Cameron: Or any similar place? Because there you see the technology and information retrieval of to-morrow, to-day. The only people who can afford this to-day have been the Armed Forces. I have seen this and I am convinced that we can use this same machinery for our national data bank, because that is what it is. However, is something like this what you have in mind?

Mr. Tyas: Well, I have not actually been to that place, but I was in Washington early this week at a special meeting in the office of Science and Technology, and a person speaking there from NASA was describing the manned space flight information services of NASA, which are along the same lines. These are very intricate, interdisciplinary information services, and they set these up. They have found that they can cut the cost of information handling by using these new techniques from 40 per cent of the R and D dollar to 22.2 per cent of it, and in the end they came down to 10 per cent of the R and D dollar; that is to say, they cut the cost of information handling by a quarter by using these techniques, and they had to get the information to these people working on things like the moon shot. They also found that for every dollar invested they saved $4: that is to say, the first year I think they were saving at a ratio of one dollar to one dollar, and at present they are saving 4.2 dollars to every dollar invested in information handling, by better services, by getting it out to the people without the people having to look for it, and so forth.

In our study here in Canada we found when we made a survey that we got some 25,000 replies from scientists and engineers in the three sectors, industry, government and the educational area, and it worked out that the cost of just not being able to find information, and having to look for it oneself, was an average of $1,800 per year per person, and if you multiply this by the enormous number of people in industry, government and universities, it works out to well over $200 million a year, so this is the cost of inefficient services. Now, NASA's recent report, which was given on Tuesday of this week in Washington, and it probably has not been published yet, indicates that these savings have been made in NASA by using these services. You cannot cut it down to zero but you can reduce it considerably by using this new technology.

Senator Cameron: You are suggesting then that it would be possible for Canada to establist a national science inventory of information?

Mr. Tyas: Yes, sir.

Senator Cameron: Have you any idea what such an establishment might cost?

Mr. Tyas: Well, we have had various estimates on that, but these estimates fluctuate rather widely, and, of course, it depends when you start to do it. The cost of things keeps on escalating and so forth, but it would possibly cost a fraction of what is now being spent in this area. I would suggest that if we spent something like 10 per cent of our R and D dollar on ensuring that we utilized our R and D properly, and we utilized the R and D of other countries, this would be beneficial to the nation to the tune of something like $100 million a year. It would be very difficult to spend that for a number of years. Technology is moving so fast that it is away ahead of its application in this area in Canada not in the United States and other countries.

Dr. A. B. Hunt, Member, National Research Council: Mr. Chairman, I wonder if I may add something?

The Chairman: Yes.

Dr. Hunt: This is not my section of the study, but we have reviewed a great number of systems, not only in Canada but a great number in the United States. I think your question was: had we seen the specific installation? No, we have not, but we have seen a number of very large installations.

Senator Cameron: Similar?

Dr. Hunt: Yes.

Senator Cameron: My friend, Mr. Campbell, is sitting over there. What have you done in your Toronto Public Library with respect to an information retrieval system, and how would it fit into the national data bank that we are talking about?

Mr. H. C. Campbell, Chief Librarian, Toronto Public Libraries: Mr. Chairman, the report which you have before you is a summary of an eight volume study. I think it is unfortunate that the other seven volumes could not be available, because many of these questions are answered actually in those volumes.

This is symptomatic of our slowness in disseminating government reports, that it will take something like a year and a half to produce these reports, which I think is a commentary on the problems which we tackle in this report. It is a problem not of fragmented individual effort, as the Toronto Public Library or the University of Toronto or various establishments do, but how do we look at the total problem as a country which has not yet looked at this problem nationally? In the supporting documents we have examples of 15 or 20 existing services which are operating: The Toronto Public Library, the University of Toronto, several government services; but the point we are making is they are all fragmented. They are all working in isolation. Many of them in fact are duplicating what others in Canada have already done, and the thrust of this very condensed summary tonight is to try to focus on the national problem. We cannot solve it on this piecemeal individual basis, and the 14 universities of Ontario have decided they have to do something about a collective large research collection of information services. I think our chapter on the government services which is, of course, the most critical one and the most delicate one which had to be written, points out that within the federal government, here is a first area of coordination of scientific and technical policies between the various departmental services. Yes, we can apply them with relatively a small amount of money. We are not talking about always hundreds of millions here, just sometimes hundreds of thousands or several millions of dollars that will secure immense efficiencies. The report on techniques and sources, which is the one which I prepared with my colleagues, only says that there are existing methods of doing things more economically, which other places are doing; let us do them in Canada now.

Senator Cameron: I would assume that you would be thinking, certainly in the initial stages of this thing, of a rather selective information-gathering system. In other words, you would concentrate on certain areas that are of most immediate need in Canada. This would involve a highly skilled and broadly knowledgeable staff. Now, have we the resources for that kind of thing to-day?

Professor C. Forget, Centre de Documentation, Laval University: No, we do not. We have several library schools in Canada which were started very recently to train librarians on information science and techniques, but they have just started. We do not have in Canada any course of information science as such, and we have to send our own graduates to the United States to get the proper course to be trained for this purpose, and that is why we need this on a national basis. One recommendation of the report is that the government grant awards to library schools in universities in order to develop and train people to tackle that job.

Senator Cameron: To be very practical about this, we are going to have to make a report by about the first of November, and this is one of the key features of it, I am sure, because we have been told time and again there is overlapping and duplication, and there are duplicate costs. Therefore, supposing this Science Policy Committee recommends that we establish a national scientific data bank for Canada, can you give us any idea of what we would need in the way of funds, or what the cost would be of the equipment that we would need to make a start? This is one thing. The second point is, if we have not got the technical staff we would need to operate this national centre now, how long would it take us to train the necessary staff? Could we select people and send them to the United States to get the

necessary training, or should we envisage setting up our own training schools for people for scientific information retrieval?

Dr. H. J. von Baeyer, Acres Intertel Limited: I believe the emphasis is not so much on building one large superstructure, one large building, housing any one super data bank. The emphasis is on what we call the network concept, where the existing institutions, facilities and organizations will remain, will be strengthened, but will be co-ordinated in such a way that they do not duplicate each other; that they concentrate on areas of excellence or specializations, so that the actual national facility is not one block; it is actually the whole country as it exists now with the majority of institutions remaining as they are, but co-ordinated in a way so that they do not do the same thing all over again. Therefore it is merely a co-ordinating function and it is a centralized inventory function to some extent, so that one centre should know where is what. This is the main point, that there is one central point which just knows what is where.

Senator Cameron: Could we illustrate it in this way? For example, the University of Toronto has probably the best aeronautical engineering service in Canada, so information in that sphere would be in Toronto.

Dr. von Baeyer: Yes.

Senator Cameron: And for the neurological sciences there is Dr. Wilder Penfield's group at McGill.

Mr. Tyas: And the Bedford Research Institute at Halifax, and so forth.

Senator Cameron: Yes. So this will be tied into the central system, and the information might be in this centre of excellence?

Mr. Tyas: Yes.

Dr. von Baeyer: Yes, they may be given a mandate to maintain this. There is a centre of that kind at the Bedford Institute in Halifax, for oceanography, which is already a centre of excellence and specialization, and other centres do not duplicate their work.

Professor Forget: The Association of Universities and Colleges of Canada has already started to work this year, and they have formed two committees, one on library resources of Canadian universities, in order to pool all our resources, and another committee on the automation of university library services. I heard just a few minutes ago that we were lacking in qualified people, but the way it has been working since we started on the automation of library services around 1964 is that certain universities have started to work on automation, and we have already duplicated many efforts, from U.B.C. to Dalhousie. The Association of Universities is now pooling all our resources, and trying to get human resources at the same time to work on programs that could be adapted from coast to coast in Canada. This, I think, is the way that it could supply the lack of trained people.

Senator Cameron: I will tell you the reason why I have such confidence that this job can be done. I was at the Strategic Air Command, and they were quite proud of the equipment they had. They said, "You can ask for anything you want, and we will show you how fast we can get it". I said, "Well, I would like information on the Dnieper Dam in Russia." He pressed a button in the machine and within less than a minute four strips about three and a half inches long by an inch wide were produced. That was the equivalent of a book of 450 pages. Then the knowledgeable man said, "All right, I want to know some detail in that book. I don't want the whole book, but I would like a section of it". So he put this plastic strip in another machine, and again within seconds the information I wanted started to roll out at the rate of 1200 words per minute. Therefore you do not need to have all of the information in the world piled together. You can get what you want in this way. But you must have thoroughly qualified people who know where it was, and who know what you are talking about when you ask them.

The Chairman: I am intrigued, senator, to see that you were interested only in dams.

Mr. Campbell: Mr. Chairman, what you need before that is a policy, a national policy, that such a thing is necessary. While the United States, Great Britain, the Federal Republic of West Germany and Japan report their policies, Canada has not such a policy. We have not the insistence that that kind of resource be available, even in the government libraries in Ottawa and the information services in Ottawa.

Mr. Tyas: Senator, we have been the second country to conduct a study of this nature, out of the 16 or 20 members of the OECD. These countries have set up focal

points in the last 18 months to deal with this problem. They have set up special agencies, because they realized the importance to their economic growth of the use of this material. Yet, we in Canada have done nothing so far about this, and if we carry on this way we will get worse and worse. I think, as regards the question you have been asking about how people know where their money is going on research, our referral centre would just show you this. There is the referral centre set up by the ILO in Geneva, which gave me a similar demonstration to yours on documents.

The Chairman: What was your question?

Mr. Tyas: I asked about Eskimos in Canada, and they went through 16,000 documents to produce 257 documents which had the word "Eskimo" in, and seven with the words "Canada" and "Eskimo". These were printed out all in 1.45 minutes with a rapid speed printer.

Then they have another device there. They persuaded the Secretary-General of the ILO that he should know where his funds, which amount to $2 million and come from all countries of the world, are going on just in-house research. They have other research outside of the organization. They put a very simple one-page questionnaire to all the people—and we have copies of this in our office—as to what their research was, what they were spending, how far the program was on. They were just feeding it into the computer, and, with visual examination of these things before they went into the computer, he said he knew the Secretary-General was going to be horrified. I cannot really say the percentage because they were not sure, but quite a large percentage of the research was duplicated in-house, in that very building, without going outside and finding what they were duplicating elsewhere. These sort of systems are essential when you are planning any policy, priority scheme, or balanced budget. I think these are the things that Senator Grosart asked at one of the previous meetings: How do people know this? They do not know. We do not know at all where our money goes to-day, and we do not know where our $1 billion of R & D funds go.

Senator Grosart: I am convinced this is fundamental to a science policy in Canada, so I hope you will have a start made on this before too long.

Mr. Tyas: The second part of our report deals with using this information to help the scientist and the engineer and then the technologist in industry to utilize the output of the R & D. This is a separate problem, but the same system gives you the same information.

The Chairman: Senator Grosart?

Senator Grosart: I have not read the eight volumes, but I have read the summary that is available and I must say it confused me a bit, because it did not suggest to me how many of these computer complexes you are going to have in Canada. It did not seem to quite get down to cases, in spite of your chart and the very full descriptions of the subject titles in the chart, and it did not get down to the hardware. Where will the hardware be, and what will it be, having in mind your emphasis on a regional network?

Mr. Tyas: We did suggest that Canada could be divided into six regions, the Maritimes, the West Coast, the Prairie Provinces, Ontario, Quebec, and a special region for Ottawa because of the large holdings in Ottawa of the federal government. These regions would be based on the provincial or regional universities, because outside Ottawa the main holdings, except for a very few large municipal libraries, are in the universities. Therefore we suggest that the first thing to do is to automate the housekeeping, really, of these university libraries, so that if you are in Halifax and you want a document, you go to the computer, it searches around Halifax, and then it searches the Maritime universities. If it cannot find it there, it automatically switches to the next region. So our first thing would be six regions with central computers all joined together, and a special one in Ottawa. Then we have suggested in our report that, over a ten-year period, this could be expanded to maybe 20 such centres, bringing in industrial complexes like the Sheridan Park complex in Toronto, and other interested groups. These extra regions or sub-regions would be smaller, they would have smaller holdings. We think that each of these regions might hold something like a million volumes or documents in a computer. This is the magnitude of the problem.

We did some approximate cost estimates on this, but again, these things fluctuate very rapidly. Maybe Dr. von Baeyer might like to say a few words about the cost of these things, but we see it building up from really, in the provinces, the universities, and in Ottawa from the federal government. Here in

Ottawa to-day there is tremendous duplication, just in federal government departments.

Senator Grosart: Would there be an allocation of subject titles by regions—an allocation of, if you like, information areas?

Mr. Tyas: I am not quite sure of the question?

Senator Grosart: Would you let Edmonton take the Eskimos, for example, and Halifax the oceanography?

Mr. Tyas: Yes, certainly. In oceanography one would ask, for instance, the Bedford Research Institute to be the research agency for Canada. Calgary would look after oil; some other place textiles, and some other place construction, and so on. Yes, there would be special centres of excellence. We would hope we would have only one such centre for these special areas in Canada, and therefore you would reduce duplication.

Senator Grosart: Would not this mean that your university group in each area would find itself in the position where it would be too specialized, and would not have the material for general university education requirements?

Mr. Tyas: I think it would specialize in an area, but it would still have the necessary documents for general education. In aeronautics, for example, Toronto, which would specialize, would have the best collection in Canada in aeronautics. I do not think you would do away with general holdings required for everyday purposes, but you would certainly reduce the special holdings.

Senator Grosart: Every medical school, for example, would have to have a fairly complete information bank?

Mr. Tyas: But they would not specialize in Parkinson's Disease, for example, or in neurological problems. So you would have very special collections only where required.

Senator Grosart: Then you would take each discipline, I take it, and subdivide it?

Mr. Tyas: You would ask someone to be responsible for that discipline in one area.

Senator Grosart: But would you have one central medical information centre?

Mr. Tyas: It is part of the whole system. You would just ask the question anywhere in Canada. You would not know where it was held. The computer would do the search and say: The volume is available; do you want it now, or do you want page 10 or the whole volume? What do you want? And it would spew it out, or post it to you, or whatever the means of transmission was.

Senator Grosart: But obviously, if you are going to make this work, it is not merely enough to make a technological information assessment of what is existing. If it is going to work properly you would have to say what should exist. How are you going to make this allocation?

Mr. Campbell: Mr. Chairman, all of this is based on what actually people require, so you would really start first with the demand side. If you have many demands for relatively similar material, then you become involved in expensive duplication, but after a while you would find, if the demand shaded off, that relatively little but highly specialized demand could be handled by a few places. You would then get the mix of duplication and multiple access for many demands and specialized access for few demands on a planned basis, rather than, to some extent, a hit-and-miss or even a completely nonexistent basis as we now have in Canada. So it is a matter of rationalizing and planning based on demand, and anticipation of demand as well.

Senator Grosart: On the other hand, a good deal of innovative use of technical information goes the other way. It depends on supply. The Japanese experience, for example, is based on the supply side rather than the demand side.

Mr. Campbell: Areas where we begin to talk about what demand consists of. Of course, part of the demand involves knowledge of what other people are doing and probably this is the area of the Japanese experience that is of most significance, that they developed a technique for finding out what other people are doing, and fed this into their operations.

Senator Grosart: That is what I mean. They said: Let us have a look at the supply, and we will see if we can use it.

Mr. Tyas: Yes.

Senator Grosart: Just one final question: What is being done at the moment about international allocation of what I call subject titles? May I put it this way: How many

places will be able to answer the Dnieper Dam question?

The Chairman: Could we have a less prosaic question?

Mr. Tyas: I think by national requirements, certain countries are specializing in certain areas. The United States has chemical abstracts, and the medical system Medlaws; the United Kingdom is doing electrical engineering and physics. These things are becoming international abstracting systems, so once this is done in one country, all countries will use it. There would be no point in Canada's duplicating it. Does that answer the question?

Senator Grosart: I would hope that that would be so.

Mr. Tyas: Well, we do in Canada.

Senator Grosart: Because, to use the chairman's term, it is the macro of the national micro problem.

Mr. Tyas: Yes. The idea is we would not duplicate things that were being done in other countries. This is why they have this strong committee of the OECD in Paris, to try to ensure that this does not happen. In the field of atomic energy, there is an Atomic Centre in Vienna, which is doing this between the East and West Nations. This is more of an international nature than the OECD. So these processes are already in being. The problem is being tackled on an international basis as well.

Senator Grosart: In your reference to the Japanese experience you speak of them buying this information or obtaining licences. How does this work?

Senator Cameron: Is not that a licence to manufacture—a patent licence?

Senator Grosart: No. I got the impression from your report that they were buying the information. Is somebody in the business of selling it?

Mr. Tyas: I am not quite sure which part of it, but they sell it to themselves. They have agents in countries who look at what is going on. They are rather like consulting firms or lawyers here. These companies are in competition with one another in Japan: they are each trying to get a new idea and sell it to Japanese industry. It is a very good way of doing business, of course, and they have made a lot of money out of it. I think that is what we meant.

Mr. Campbell: Again it comes back to the demand. They are not doing this for 10,000 industries or products; they are doing it for selected areas in which, in one way or another, priorities have been established. For instance, the best example of their information services is in the area of shipbuilding, because they deliberately felt that this was one way in which they could capitalize on the available knowledge for a specific market, and the concept of mixed private enterprise and public enterprise, arrangements for handling this knowledge, is something which I think we can also look at.

Senator Grosart: Except that, on an international basis, you would expect that centre to be in Belfast rather than in Yokohama.

Mr. Campbell: This is the way things change. The one thing in the international development which is most important is standardization and the agreed utilization of standards and standardization in the information field, and this the international agencies are mainly responsible for, establishing international standardization, whether it is between the contents of computer banks, or descriptions of periodical titles, or all the other technical devices necessary to handle information rapidly. Again a federal government service in Canada would have a very important responsibility for standardizing and assessing standardization within Canada, both in the public and private sectors, which we still need.

Senator Cameron: Mr. Chairman, Mr. Tyas has suggested that we set up a scientific and technical information agency of Canada. Could you tell us how many countries in Europe have this kind of establishment now?

Mr. Tyas: I cannot tell you all of them.

Senator Cameron: Well, no, but some of them.

Mr. Tyas: The United Kingdom has this office of Scientific and Technical Information called OSTI. It is in the office of Education and Science. As I mentioned, the head of it has just been made an Under-Secretary, which is equivalent to our Deputy Ministers, and now I think he is Under-Secretary of Libraries and Information Services. This is the first such senior office to be created, I think, in any of the western countries. In

France they have set up a special organization to do this. In the Netherlands they are setting up a government agency; it has not formally taken over yet, but it is going to take over. The Swedes have a similar system. I really do not know of any more, but there are many examples in Europe and we could find them for you if you like.

Senator Cameron: I wonder, Mr. Chairman, if this group could give us a sort of prototype of what kind of an organization they would like to see. They have partly described it, but I think, for our purposes as a committee, it would be useful to have it spelled out precisely. I have your chart here, but we have to have more than this. This is a schematic diagram of the kind of organization, but now we have to be effective. It is not enough for us to say, "Well, we suggest this agency be set up", because, very shortly after this, the government is going to say, "All right, you have recommended this agency; how much is it going to cost? How many people in terms of manpower are going to be involved?" and so on. I think it would be very helpful to us if you could go a little further than you have in this document in spelling this out, as a working model of what we might have for Canada.

Mr. Tyas: First of all, may I say a few words about this, and then maybe somebody else can add something. This agency we have suggested here is to tackle the problem. This is an immense problem, and it is in sectors, so therefore there is the government bit of it, and an industry bit, and so forth. It is probably a very small agency compared with most government agencies, where they would plan these things, and they would do the cost studies, because to do this cost study, it has to be done when you know the type of system you are going to put in; you know whether you are going to have six regions or ten regions, and when we have a decision by the government to go ahead with it. Costing means nothing now if you are not going to implement it for five years, so I think this agency is really the prelude to putting some of our ideas into operation. It is not just the operational agency. For example, under the network evolution there, we would expect a lot of the present organizations in government to help with this, so this is really the body that would do the planning which we are asking for now. We found this was an immense task that we carried out, and we did not get down to that kind of detail, even in our seven other volumes, which are 1,000 pages long. We just did not get into that.

The Chairman: I presume it would have been a useless effort until there is a government decision?

Mr. Tyas: Yes, it really is.

Senator Grosart: Can I put the question in this way: Assuming, as you quite rightly say, that the starting point is the decision to have a national policy, and then to set up your OSTI agency; if this was done could you give us an idea of what you see happening in the first year?

Professor Forget: The first thing would be the co-ordination of effort. Already we have resources in Canada that are quite tremendous, but we have a lack of communication, and it would be necessary to maximize the resources that we already have. It is true that the government is concerned, because we need authority to go all through Canada and ask the right questions and complete the inventory of what we have, and let everybody, all the users or the potential users in Canada, know what already exists. Now, at the same time I think you asked in the first year. Well, I think we should try to get into Canada all international resources that exist, that are available, and we could put them at the disposal of anyone by creating a national agency providing for it. I think that already in the first year that would be a tremendous step forward, compared with the position we have to-day.

Senator Grosart: But how do you do it? I am now interested in the mechanics. Do you send a team out? What do they have with them? Do they have mini-computers to assess this? What happens in the first year? You say, "Co-ordinate and maximize", but this does not really mean anything to a government. When you say, "You have got to put this in your Estimates," you have to say what for.

Dr. Hunt: Mr. Chairman, I would like to answer Senator Grosart's question along the lines that you have heard many times, that people have made great errors in setting up a computer to do a big job before knowing what the job is. We have learned in industry you do not just buy a computer and get into the computing business. You have to have a plan before you start. In particular I would like to come back to one of the earlier questions. In addition to many possible centres that you are talking about, what we are greatly interested in in industry is the mission-oriented information analysis centres. Well,

you have to first of all know what you are going to analyze, and what they want, before you start setting up a computer system to handle it. I think one of the best examples is, of course, the pulp and paper industry; their research is probably one of the best in Canada, which is gradually becoming computerized, but it is a good example of a mission-oriented information centre.

Senator Grosart: But you have to orient all missions.

Dr. Hunt: You have to do it, yes. They are talking about four. Maybe some of them are small, but they are going to draw their information from the major information banks, but they have got to analyze it and put it in a form which can be used by industry. I started to mention the construction industry, in regard to which I think the Department of Industry, Trade and Commerce, have made a considerable study on this, and they feel that in fact with the support of industry, and it will be paid for by industry, they are prepared to set up some sort of complete centre for that type of service. In other words, you have to know what you want before you start to get the hardware.

Senator Grosart: Surely you want everything here. Is not your problem in programming the computer. You really know what you want your computer complex for now.

Dr. Hunt: No, excuse me, I do not think they do. Again I would refer to the construction industry. It is a fact that what they want is much more than they probably will ever get; in other words, they want prices on every type of material and at any time and any place. That is just one thing. Is that the type of information that is really worth while? Is it moving too fast? Is it available, because in different localities it changes. If you ask anyone in the construction industry they are extremely interested in prices. In other words, maybe you will have to get stable prices—well, I will not say stable, because nothing is stable to-day, but when you get into the technology field, although things are moving rapidly, they are not moving as fast as prices are. So you have to decide what would you need to set up a computer system to supply the construction industry with all the price information they want? Maybe it is not feasible, so you do not set up a computer system to handle it; you find out whether it is feasible first.

Senator Grosart: Yes, but surely you are going to start with an assessment and collation of all the material that is now in existence in libraries of all sorts. Is this your starting point? What do you do in the first year?

Mr. Tyas: Would you like me to deal with that, Mr. Chairman? I think that what we would like to do, as the first thing, is to set up this referral centre so that we know who is doing what and where the information is. That is a fairly simple thing to set up, and relatively inexpensive for what it gives. It would probably take about a year to set it up, and would probably cost about $1 million, and probably involve a dozen or so people. Then the next thing we would like to do is to automate as much as possible the housekeeping functions of these regional libraries, that is many university libraries and the federal government libraries here in Ottawa, so that the libraries are on-line with their collections, and when you want something you can ask for it and the computer says where it is and whether it is available in Canada or not. Then the next thing is these mission-oriented systems for industry which Dr. Hunt has just been talking about. In this case there is one going into the Department of Industry. It will be in by Christmas. It will have 12 pilot outlets across Canada. By next summer they will have assessed its usefulness to the construction industry. The construction industry is very willing to pay for this. They have tremendous estimates; they think they are spending about $300 million to-day on information in the construction industry. We do not necessarily believe that, but they say this.

Senator Grosart: You mean world-wide, of course?

Mr. Tyas: No, no; in Canada to-day. That is three per cent of their total output.

Senator Grosart: They are spending $300 million a year?

Mr. Tyas: Yes, this is what they say.

The Chairman: You mentioned a figure of $30 million.

Mr. Tyas: No. This is scientific; this is all the way down to their lower level of technical information, $300 million. This study was done, and some 10,000 questionnaires went out to the construction industry to get these figures, and they believe that for $2 million to $5 million a year they can get an automated

system which will give them all this information.

Senator Grosart: And yet we were told here in no uncertain terms that the construction industry spent no money practically on research.

Mr. Tyas: No, they do not; this is quite right; but they spend a tremendous amount on information.

Senator Grosart: Is this not research?

Mr. Tyas: No.

Senator Robichaud: The research has been done already.

Mr. Tyas: Yes, and this comes down to the very lowest level, of how you put these light fixtures in, how you fix the heat vents, and how you put insulated windows in, and so on. It is technical information to the construction industry. They require this, and it is in great demand. $300 million is less than three per cent of their expenditure each year; they spend over $10 billion.

Senator Robichaud: This is a high price they are paying to find out how to apply research that has already been done.

Senator Grosart: In my book, research on research is research. We have heard here many times, I think, that industry is spending a lot more money on research and development than they make out a case for.

The Chairman: You will not change the definition to-night. According to DBS, and all those agencies collecting data, they classify the money spent on information as being spent in scientific activity, of course, but not in R & D.

Senator Grosart: I do not have to agree with their definition.

The Chairman: You do not, but, we will not change it to-night.

Senator Grosart: I do not have to agree with their definition any more than I have to agree with the National Academy of Science's definition of R & D, which leaves out the whole field of sociology.

Mr. Tyas: In addition, in the first year, Mr. Chairman, we would like to strengthen the technical transfer services to industry. This is a regional system of information offices in industrial regions, to get this information out to industry, especially the small industries which cannot afford their own libraries and internal services. This is an extension of the NRC-TIS services, and that is another thing which you could easily expand in a year. You could move into it, and build it all up. These are the sort of things we would like to do in the first year, but this is a ten-year plan to do this. You have to have a very good planning staff, and the first thing is to get the government to agree it is important and then to set up the agency to plan it. This is really a planning agency, not just a controlling agency.

Senator Grosart: What I am suggesting to you is that the way to get the government to agree is to show them what is going to happen in the first year, and what they have to put in the Estimates.

Senator Cameron: Mr. Chairman, this has been a very valuable session and it bears upon one of our most crucial problems in science policy. I would like to say that we are very grateful to this group, and I would like to feel that we may call upon them if we need some more expertise when we are formulating our recommendations.

The Chairman: I would like to ask a question here. I have been rather neglecting myself to-night.

Senator Grosart: That is unusual!

The Chairman: When the Macdonald study group made their study did they consult with you, especially when they were writing their several chapters dealing with libraries?

Mr. Tyas: Yes, I did have discussions with Mr. Macdonald, and he helped us with some of our university problems.

The Chairman: Suppose, for instance, that your centre were to be set up; would this change the money aspect of their recommendation?

Mr. Tyas: Of the university recommendation?

The Chairman: No, the figures they have produced about the needs of libraries in Canada.

Mr. Campbell: Mr. Chairman, the problem here is not to change their figures, but it is to make sure that the money is well spent, as far as the dissemination of scientific and technical information is concerned. I think our

report may be somewhat critical of the lack of access by the users to scientific and technical resources in university libraries. These are not easy problems to solve. We know that the universities are our best resource, but we also know that they are largely unavailable to many hundreds and thousands of technical and business people who could use the information. There is a conflict here which we feel it is in the interests of the federal government to look at and to mediate, because it is not going to be done by the universities themselves, any more than by any other sector of the economy.

The Chairman: But you say that one of the purposes of this new centre would be to minimize duplication and to develop co-ordination. Surely if this is one of the purposes, it would mean that without that system the cost of supplying our need of information, including the cost of buying more books for libraries, would increase? If the Macdonald study did not take into account your proposal, then perhaps some of the figures they mentioned would be too high.

Mr. Tyas: Well, in another report the results of the Bond report were looked at by Blackburn, the head of the Toronto University Library, and he estimates that in the next ten years they will spend 2.25 billion dollars on library resources. That is not just scientific and technical, but all library services in Canadian universities. But this is a horse-and-buggy approach this is duplicating the collections of millions of volumes in 40 libraries all across Canada, and they are all asking for the same sort of resource that Toronto has got. If we are going to go ahead with that, that is an average of $225 million a year for a ten-year period, and that is ludicrous. This is the problem you are faced with: are you going to go ahead with this on a piecemeal, uncoordinated approach, or are you going to co-ordinate it, bring in new technology, and reduce the cost considerably?

Dr. Hunt: Mr. Chairman, I think the direct answer to your question is yes.

The Chairman: That was a brief answer, but very clear. In case I will get another very clear and short answer like that, I think I will raise no more questions.

Thank you very much. We have certainly got your message to-night, and, as Senator Cameron has suggested, we might be in contact with you again, even if it is not through a public hearing. I suppose that at present this report is before the Science Council?

Mr. Tyas: Yes, sir. They expect to have their report on this out sometime in early 1970.

Senator Cameron: We cannot wait.

Senator Grosart: This is another of the Science Council's publications about which they say: It has our name on it but it is not ours.

Mr. Tyras: That is not theirs, but the red one, which will come out in January, will be theirs.

The Chairman: They do not have the same colours.

Mr. Tyas: No.

The Chairman: Well, thank you very much, gentlemen.

The hearing adjourned.

APPENDIX 185

THE SENATE'S SPECIAL COMMITTEE

ON SCIENCE POLICY

ROYAL ARCHITECTURAL INSTITUTE OF CANADA

A Brief Presented by Dr. Thomas Howarth, Dean Faculty of Architecture, Urban & Regional Planning and Landscape Architecture, University of Toronto, on behalf of the Royal Architectural Institute of Canada at the request of Mr. Norman H. McMurrich, President, R.A.I.C.

Senate's Special Committee
on Science Policy
Ottawa.

15th May, 1969.

Gentlemen,

It is a pleasure to submit the required copies of the brief prepared by Dr. Thomas Howarth, PH.D., F.R.A.I.C., F.R.I.B.A., on behalf of the Royal Architectural Institute of Canada.

We trust that this brief furnishes the information which the Committee is seeking and commend the recommendations which it includes.

Yours respectfully,

Norman H. McMurrich

Norman H. McMurrich
President, R.A.I.C.

NHMcM/mmf

CONTENTS

RECOMMENDATIONS

1. It is recommended that as a matter of immediate urgency a Special Committee be set up by the Federal Government to investigate, with the collaboration of national professional bodies and Canadian Universities, the possibility of establishing an interdisciplinary programme of environmental studies at national level.

2. It is recommended that interdisciplinary task forces, or working parties be formed as soon as possible and preferably on a regional rather than on a provincial basis to advise the proposed Special Committee.

3. It is recommended that one of the first responsibilities of the Special Committee and its task forces should be an assessment of the research potential of the Universities of Canada with a view to establishing a hierarchy of centres and sub-centres where effective work in the environmental field could be done and new lines and methods of communication be developed without necessarily conforming with existing patterns.

4. It is recommended that notwithstanding the establishment of the Special Committee, ways and means be found of providing substantial financial resources for the development of interdisciplinary research in the environmental field.

Recommendations (continued)

5. It is recommended that architecture be recognised as one of the basic disciplines relating to environmental studies and that the Royal Architectural Institute of Canada and the University Faculties and Schools of Architecture and Environmental Design be represented on the Special Committee and on such policy forming bodies, work parties, task forces and research projects as may be established by the Special Committee.

TH/mmf
30th April, 1969.

CONFIDENTIAL

THE SENATE'S SPECIAL COMMITTEE
ON SCIENCE POLICY

ROYAL ARCHITECTURAL INSTITUTE OF CANADA

A Brief Presented by Dr. Thomas Howarth, Dean, Faculty of Architecture, Urban & Regional Planning and Landscape Architecture, University of Toronto, on behalf of the Royal Architectural Institute of Canada at the request of Mr. Norman H. McMurrich, President, R.A.I.C.

1. The role of the architect in the modern world is expanding rapidly and is becoming more difficult to define with any degree of precision. As projects increase in size and complexity with the growth of urban populations the boundaries between his traditional activity - that of designing and supervising the construction of buildings - and those of allied professions and development agencies, are becoming increasingly blurred. The design of a Place Ville Marie, or a Toronto Dominion Centre, for example, is an interdisciplinary exercise of great complexity involving metropolitan and city government and services, management and financial agencies, a mixed and varied clientel, a multiplicity of users, and demanding scientific, technical and professional competence of a high order. Moreover, quite apart from the impact of an element of this magnitude upon the organisational fabric of the city, its visual and esthetic qualities may affect fundamentally the character of a whole district or, indeed, of the city itself.

2. In preparation for professional life the student of architecture is required to complete a rigorous programme of studies extending over five or more years. During this time he will cover a wide spectrum of subjects some in considerable depth ranging from applied science and engineering to landscape and fine art. Since the war much greater emphasis has been placed upon the humanities, and the behavioural and social sciences, and it is significant that students of architecture, recognising their need for a better understanding of human response to the physical environment, favour elective subjects in these fields and will devote themselves enthusiastically to studies relating to human factors in design. Such studies may have to do for example, with everyday things in a domestic setting; movement patterns of people at home, at work, or at play; the significance of street architecture; squares and parks as important elements in urban living; or the functional, psychological and esthetic effects of megastructures.

3. To a greater extent that ever before the architectural student to-day is encouraged to concentrate upon fundamental issues, to attempt to find those universal principles that will apply to most, if not all design problems that he is likely to meet in professional life, and to develop a systematic and logical method of working while learning how to draw upon the resources of the academic and professional worlds. Thus the emphasis is shifting rapidly from product to process, with internal and external interdisciplinary communication a vital element in the educational pattern. It is interesting to note also that the

media through which the student expresses his ideas and records his experiences are being extended beyond the traditional skills of drawing, painting and model-making, to include modern audio-visual techniques such as still and movie photography, videotape, and computer graphics. Although he is expected to keep up-to-date his knowledge of materials and methods of construction, he must acquire also some understanding of new management techniques, information retrieval and the elements of computer science so that he may appreciate the implications for his profession of developments in these important fields.

4. In the world of professional practice many architects have had to make radical adjustments to their traditional method of working and there have been groupings and re-groupings of individuals and firms to meet the challenge of new kinds of programmes some of which have assumed major dimensions. In such a situation the role of the architect has largely changed from that of the individual "designer" to that of a participant in a team; sometimes he will be the leader, sometimes not, depending largely upon the quality and nature of his contribution. Large design projects, particularly those related to urban renewal, often radically change the lives of many people and affect the very nature and character of a city and sometimes of a region. In such cases political, economic and social factors assume greater significance and, indeed, may be the prime determinants with the decisions made by a committee rather than by an individual. This kind of inter-

disciplinary, multi-faceted problem, with human values and aspirations at its very core, is often loosely described now as "environmental". The individual or group of individuals attempting to give physical form to the model produced by the interplay and inter-relationship of the many forces involved, is sometimes called "environmentalist". It would seem, therefore, that we may expect a new kind of professional man to emerge in the future, an individual specially trained to fill the role of the supreme designer and/or co-ordinator. At the moment the range of an architect's education and practice which spans the arts and sciences and emphasises human values, would seem to provide a good background for this kind of person and in many cases, this has proved to be so.

5. Although it has been necessary here to stress the changing nature of architectural practice there can be no doubt that for a long time to come the majority of architects will be concerned primarily with the design and construction of a building or buildings that may, or may not form part of some comprehensive planning project. In any case a great deal of continuing research on scientific and technical problems relating to materials and methods of building construction, and mechanical equipment will be necessary. In this context building performance should be understood to comprehend not only such practical matters as the weathering of materials and maintenance, but functional performance as a solution to the owner's and user's programme and, of course, physical and esthetic performance in the immediate environment.

6. In the light of the foregoing it is interesting to note that the architectural profession in North America has until quite recently concerned itself hardly at all either with basic, applied, or development research. In fact the profession has not, and does not normally recognise research as a legitimate professional activity, and the student wishing to make a career in this field would normally be excluded from the professional register and be thus denied, in Canada at least, the privilege of calling himself an architect. In the last five or six years, however, there has been a marked change in the climate of opinion, and a considerable amount of research work is being done by graduate students and some members of the profession, but it is still relatively unorganised, quantitatively insignificant, and qualitatively of varying merit. The reasons for this are not far to seek. Traditionally architecture is an action discipline. The architect has been a designer and implementor and, on graduation, was particularly anxious to immerse himself in practice. Schools of architecture have tended to concentrate upon "design" as the be-all and end-all of an architect's education. Such graduate courses as were offered , certainly in the major American universities, were little more than extensions of the undergraduate design programme. Research in the real sense of the word had no place in such a system except in the fields of history and theory. Ph.D programmes in architecture were virually non-existent and, in fact, there has been almost no demand for them. The considerable expertise and specialised knowledge

an individual might have developed during his undergraduate programme and beyond, were usually directed towards professional ends, and became primarily the concern of the firm which he owned, or in which he was employed. In the past the architect has seen himself almost exclusively in the role of creative designer and implementor and, by and large, has been content to let his finished work speak for him. The pursuit of knowledge in a particular field and scholarly and scientific presentation of ideas and technical information does not come easily to the individual trained as a man of action. Although the architectural profession has yet to develop its full scientific and research potential there can be no doubt that the records of many firms and the knowledge of innumerable practitioners constitutes a vast and virtually untapped reservoir of valuable information on town and city planning, and the human and practical aspects of building design and performance. Moreover the individual and group research work of a new generation of graduate students in fields as varied as, for example, community design for Canada's northland, industrialised and systems building, urban problems, hospitals, housing, climatic factors and comfort in buildings give great promise for the future.

7. In a time of rapid change and uncertainty the advantages of a new and relatively uninhibited approach to research and development may indeed outweigh the disadvantages of lack of tradition and established methods and procedures.

8. In the area of scientific and technical research a great deal of extremely valuable work has been done over many years by government sponsored research organisations. Much of this is basic and applied research often of an unspectacular though no less important nature. One of the first, if not the first institution to attain an international reputation in this field was the Building Research Station in England. In recent years the Division of Building Research of the National Research Council, Ottawa, under the energetic direction of Dr. Robert Leggett, has become known throughout the world for the excellence of its work and publications and needs no description here. It should be said however, that the programmes undertaken by the Division are particularly relevant to Canadian conditions, and prolonged studies have been, and are being made of problems such as fire prevention, muskeg, thermal conductivity, insulation and so forth. Work of this kind demands well-equipped laboratories and highly trained technical staff. However, many of our faculties and schools of architecture and environmental design have the potential for making important contributions in a wide range of scientific and technical subjects and interest in this kind of activity is growing rapidly among staff and students. Many practising architects too are developing their own research projects, and it would seem evident that tremendous impetus could be given to the whole research field if all this work could be properly co-ordinated, and related to that being carried out by industry, and private and government sponsored agencies.

9. In this latter regard a start has been made by the Research Committee of the Royal Architectural Institute of Canada which amongst other things is investigating conditions and facilities for research at Canadian universities, preparing a record of completed and ongoing research projects, and attempting to discover sources of funds for research. The College of Fellows of the R.A.I.C. is building up a scholarship fund for graduate research although in its national context this will be inevitably a limited and very modest contribution.

10. Quite apart from the difficulty of obtaining adequate financial support for research that cannot easily be classified as "scientific" and/or "technical" one of our main problems is that of finding well qualified research personnel. Such individuals are only now beginning to emerge from universities and research stations in different parts of the world where work in the environmental field has been taken seriously, and it would seem that while we are building up our own expertise we will have to absorb some scholars and researchers from overseas and south of the border.

11. It will be evident from the foregoing that the range of research activities that may contribute to the improvement of the built environment is extensive indeed comprising on the one hand investigations into materials and methods of construction and the problems of providing comfort in buildings to, on the other hand, the human aspects of urban, rural and new town development not only in Canada's southern region, but in her central corridor, and

northland.

12. The architectural profession is particularly aware of the urgent need for a new approach to research in the field of housing in Canada* and it is recognised that the inadequacy if not the downright failure of much of our housing and urban development is due not to lack of imagination or technical inefficiency, but rather to the disregard of existing information and the apparent inaccessibility of relevant knowledge on the way in which people live and respond to their physical environment. Ways must be found of breaking down interprofessional barriers and improving communication between, for instance, the social worker, economist and architect.

13. In this context it is significant, perhaps, that the first serious interchange of ideas between scientists, sociologists and other interested professional groups at the University of Toronto occurred in March 1969. One of the statements made was that "science policy depends on social policy" - a recurrent theme throughout the debate. It would seem, therefore, that an attempt should be made as soon as possible to set up a new kind of research programme on a national basis that would encompass those disciplines concerned with environmental problems and which would include architecture and planning as central rather than peripheral disciplines. It may be necessary to develop

<u>footnote</u>
* The R.A.I.C. recently arranged an interdisciplinary two day conference in Toronto of some thirty people in order to obtain an informed and balanced appraisal of the Hellyer Task Force Report. Its findings were published in "<u>Architecture Canada</u>" the journal of the R.A.I.C. No.3 volume 46 March, 1969 pages 41-53.

special and advanced techniques for dealing with the problems of this kind of study and research, and the participants - individuals, institutions, and even governments - should be persuaded to collaborate so that positive results could be achieved without wasteful duplication of effort and uneconomical dispersal of capital investment for facilities and equipment. This would seem to point again to the need for an overall policy, and a framework into which each contributing unit could be built and its contribution defined within reasonable limits allowing, of course, for essential growth and flexibility.

14. The Research Committee of the Royal Architectural Institute of Canada is concerned with the development of research programmes in faculties and schools of architecture, and by individuals and groups of professionals. This body should be able to make an important contribution to the formulation of research policy in the environmental field.

15. There would seem to be little doubt that if we are to meet the urgent needs of our rapidly growing and dynamically changing society an interdisciplinary research policy of the kind described here will be essential. The task of creating a satisfactory physical environment is, without doubt, one of the most important and pressing needs of our time.

Respectfully presented,

Thomas Howarth

Thomas Howarth, Ph.D., F.R.A.I.C.
F.R.I.B.A.

TH/mmf
30th April, 1969

APPENDIX 1

The Royal Architectural Institute of Canada with headquarters in Ottawa is the national body representing a membership of 2,851 architects (1968) - each of whom is registered in one or more of the nine provincial associations.

The President (1969) is Mr. Norman H. McMurrich, of Somerville, McMurrich and Oxley, Toronto. Mr. Wilson Salter, F.R.A.I.C., is the Director of Professional Services and Mr. Maurice Holdham is the Executive Secretary - they have their offices at the Ottawa headquarters.

There is a Council of fifteen members which includes one member from the Council of each of the provincial associations.

There are six Standing Committees of the R.A.I.C.Council - Architectural Education : Scholarships and Awards: Research: Competitions: Public Information: Legal Documents and through special Joint Committees liaison is maintained with Federal Government Departments, Crown Corporations and other National and International Associations.

The Royal Architectural Institute of Canada has membership in the International Union of Architects, the Commonwealth Association of Architects and recently the Pan American Federation of Associations of Architects.

The official journal of the R.A.I.C. "Architecture Canada" has a wide circulation at home and abroad and, in addition, the Institute publishes "Architectural Directory Annual" and the Allied Arts Catalogue.

A.D.A. lists the following:-

a) Registered Architects in Canada, their addresses and telephone numbers.
b) Architectural practices by Provinces.
c) Professional, Business, Manufacturing and Trade Associations.
d) The Building Construction Index of Products and Manufacturers.

The Allied Arts Catalogue illustrates examples of work in various media by artists who have either collaborated with architects, or contributed work directly to buildings. Two volumes have been published to date.

TH/mmf
April, 1969

APPENDIX 11

Canadian Universities Offering Courses in Architecture and Allied Disciplines

British Columbia

University of British Columbia:

School of Architecture — Director : Professor Henry Elder

Degrees offered : B.Arch.
M.Arch.

Manitoba

University of Manitoba:

Faculty of Architecture — Dean : Professor Roy Sellors

Degrees offered : B.E.S. (Bachelor of Environmental Studies).

B.Arch (also B.Arch with Urban Design option).

B.L.A. (Bachelor of Landscape Architecture).

M.Arch.

Diploma City Planning

Master of City Planning

Ontario

University of Toronto:

Faculty of Architecture, Urban & Regional Planning and Landscape Architecture. — Dean : Dr. Thomas Howarth

Degrees offered : B.Arch.

M.Arch.

B.L.A. (Bachelor of Landscape Architecture)

Diploma, Urban & Regional Planning

M.Sc(Pl) - Master of Science in Urban & Regional Planning.

Carleton University

School of Architecture — Director: Professor Douglas Shadbolt

Degrees offered : B.Arch. (course started in session 1968-69).

Ontario (continued)

University of Waterloo

Division of Environmental Studies

School of Architecture — Director : Professor Tore Bjornstad

Degrees offered : B.E.S.(Arch) - Bachelor of Environmental studies in Architecture.
B.Arch.

(both courses started in session 1967-68)

Quebec

Université de Montreal

École d'Architecture (a Department of the Facultie de l'Amenagement).

Dean : Professor Guy Desbarats.

Degrees offered : B.Arch.
M.Arch.

Université Laval

École d'Architecture — Director : Fernand Tremblay

Degrees offered : B.Arch.
M.Arch.

Nova Scotia

Nova Scotia Technical College, Halifax

School of Architecture — Director : Dr. Peter Manning

Degrees offered : B.Arch.
M.Arch.

Projected

Alberta

University of Alberta : Edmonton Campus
(programme now being formulated).

TH/mmf
30th April, 1969.

APPENDIX 186

BRIEF SUBMITTED TO

THE SENATE SPECIAL COMMITTEE ON

SCIENCE POLICY

BY

BORDON B. THOMPSON

REGENERATIVE PLANNING

a presentation by Gordon B. Thompson Kanata·Ontario

I would like to express my hope that any science policy that is adopted for Canada increases the innovative and creative aspects of a field where these traits are not too evident. Writers such as Thomas Kuhn have told us that the major occupation of the scientist is working at problems within the prescribed confines of the acknowledged models or paradigms of the speciality concerned. Little effort is expended in questioning these paradigms, or in searching out new ones. In a society that accepts a rather low level of creativity as a norm, as evidenced by much that we see in our art galleries and elsewhere as contemporary art, I suggest that we have a real basis for concern.

Formalization of what is, and what is not science could lead to a still further reduction in the creative output of our scientists. Ecological studies have been made of the strategies used by whole populations to deal with the problems of a changing environment. These studies suggest that the most successful strategy is one in which the ability to adapt is preserved in spite of specializations required to deal with the current crises. The crisis of the present is dealt with by a differentiation of effort, but in addition, the capacity to adapt to future crises is ensured by preserving the ability to throw off the effects of over-specialization. In the hydra used in these studies, the level at which the specialization occurred, depended upon the length of time the crisis lasted. Many levels of adaptation were found, each taking a longer time to react. In a thinking and communicating population, strategies can be designed to build in this same kind of multi-layered protection of the ability to adapt to crises still in the future.

The term "regenerative planning" has been coined to make reference to the ability of a biological cell of this type to change from a specialized state, back to a more generalized state, so permitting it to become another kind of specialized cell. In strategy design, a particular plan of action may be no longer viable, and will have to be replaced by a more generalized type of approach until the situation clarifies itself. The key in each of these examples is the preservation of the ability to go back to a more generalized, less specific state, or plan.

In the field of long range planning, the delineation of a plan or policy can make the future such a well accepted situation as to inhibit the

possibility of any new and unexpected developments being used effectively. Although this sounds trite, the danger is very real and grave. Commitment to a plan or policy tends to limit one's expectations to just the goal-set of that plan and no more. The concepts of regenerative planning would suggest that the more concrete the main plan becomes, the more effort is put into activities designed to prove the plan either inadequate, or just plain wrong. For every hundred dollars bet on the prescribed winner, place five or ten on the long shots. It's just common horse sense.

A long range plan or policy is necessarily a form of consensus arrived at by a group of people. This process almost insures that the result will be conservative and perhaps even uninspired. This sort of plan is a kind of largest common denominator of the ideas of each member of the group. Perhaps such a plan or policy should then be considered merely a minimum standard of expectation, acceptable only in the absence of any significant creative happening. With this attitude or premise, the activity of trying to prove the inadequacy of the main plan becomes natural, and needs no justification - only support.

In my work at the Northern Electric Research Laboratory, this very technique has been actively used. Because of the flow of advertising and other cultural influences from the United States, many of the aspects of our future in the communications area are dictated by the future that they choose. Not being owned by the American firm doing most of this choosing, has allowed my company to devote a meaningful amount of effort to the questioning of these futures. As you might expect, we find that there is no scientific basis upon which this choosing is based, inly the notions present in commerce at its simplest levels. My work, and the work of others in the field, suggests that there might eventually be a science that could predict the effects a specific communications system would have on a particular society, given the communications history of that society. Experimental work and historical analysis have been used to generate a technique of ranking such systems in terms related to communications, terms that are free of cultural bias, and are primarily process oriented. The second phase of this work will involve the variations induced by cultural differences.

The primary thing here is that as a result of "going back" and questioning the essential basis of the communications planning, and developing the generalizations and integrative insights necessary to do this work, a technology of communications system design is now apparently emerging. Sciences frequently grow out of new technologies. What we will do if I succeed in proving the plan wrong in this particular case is not the point, we are concerned only with the fact that here is an example of regenerative planning at work. Although this work is not scientific in the currently accepted sense, we are attempting to perform the tasks in a scientific way. The effort is not very significant in

terms of our total budget, but conceptually we feel it is important. Here we are doing more things scientifically, rather than just doing more scientific things.

It is hoped that any science policy set out for our country would encourage such activities. Too rigid a definition of science could lead to the suppression of this near scientific enterprise. Such definitions seem to appear in legislative instruments designed to encourage scientific or other worthwhile activities. If we as a society hope to use our scientific abilities to advance our position, we must be careful that we do not build walls that are defined in yesterday's terms, walls designed to prevent abuse, but walls that may deny us the full potential we seek. If a national or federal science agency is needed, one that is concerned with setting goals and policy, surely the Economic Council of Canada provides a model worthy of consideration. The very respected and yet subtle pressures generated by this organization provide a most interesting example of control without restriction.

In summary, my concern is that in detailing a science policy for Canada — if indeed we need one — that we stimulate the creative potential of our scientists. On the other hand, we certainly should not embrace the "quack". Sometimes this line is very thin, and great wisdom will be required to discern the difference. Too strict an adherence to the letter of established science could be very, very expensive in terms of lost opportunity.

Our artists tell us that we have a terribly low level of creativity with their "art is anything you can get away with" type of displays. Let us generate policies of science that prove the artist has seen too limited a view of our society. Senators, you have a formidable task.

June 26, 1969

Gordon B. Thompson,
Kanata Ontario.

Queen's Printer for Canada, Ottawa, 1969

First Session—Twenty-eighth Parliament

1968-69

THE SENATE OF CANADA

PROCEEDINGS
OF THE
SPECIAL COMMITTEE
ON

SCIENCE POLICY

The Honourable MAURICE LAMONTAGNE, P.C., *Chairman*
The Honourable DONALD CAMERON, *Vice-Chairman*

No. 77

FRIDAY, JUNE 27th, 1969

WITNESSES:

The Sheridan Park Association: Dr. M. Grace, General Manager, Dunlop Research Centre; Mr. A. J. Wellington, Manager, Product Research Centre, Cominco Ltd.; Mr. W. R. Stadelman, President, Ontario Research Foundation; Mr. Donald Holland, Director, Research and Development Program, Department of Trade & Development, Province of Ontario; Mr. Bruce Hewat, Vice-President, Sheridan Park Association.

APPENDIX:

187.—Brief submitted by The Sheridan Park Association.

20678—1

MEMBERS OF THE SPECIAL COMMITTEE

ON

SCIENCE POLICY

The Honourable Maurice Lamontagne, *Chairman*

The Honourable Donald Cameron, *Vice-Chairman*

The Honourable Senators:

Aird
Belisle
Blois
Bourget
Cameron
Carter
Desruisseaux
Giguère
Grosart
Haig
Hays
Kinnear
Lamontagne
Lang
Leonard
McGrand
Nichol
O'Leary (*Carleton*)
Phillips (*Prince*)
Robichaud
Sullivan
Thompson
Yuzyk

Patrick J. Savoie,
Clerk of the Committee.

ORDERS OF REFERENCE

Extract from the Minutes of the Proceedings of the Senate, Tuesday, September 17th, 1968:

"The Honourable Senator Lamontagne, P.C., moved, seconded by the Honourable Senator Benidickson, P.C.:

That a Special Committee of the Senate be appointed to consider and report on the science policy of the Federal Government with the object of appraising its priorities, its budget and its efficiency in the light of the experience of other industrialized countries and of the requirements of the new scientific age and, without restricting the generality of the foregoing, to inquire into and report upon the following:

(*a*) recent trends in research and development expenditures in Canada as compared with those in other industrialized countries;

(*b*) research and development activities carried out by the Federal Government in the fields of physical, life and human sciences;

(*c*) federal assistance to research and development activities carried out by individuals, universities, industry and other groups in the three scientific fields mentioned above; and

(*d*) the broad principles, the long-term financial requirements and the structural organization of a dynamic and efficient science policy for Canada.

That the Committee have power to engage the services of such counsel, staff and technical advisers as may be necessary for the purpose of the inquiry;

That the Committee have power to send for persons, papers and records, to examine witnesses, to report from time to time, to print such papers and evidence from day to day as may be ordered by the Committee, to sit during sittings and adjournments of the Senate, and to adjourn from place to place;

That the papers and evidence received and taken on the subject in the preceding session be referred to the Committee; and

That the Committee be composed of the Honourable Senators Aird, Argue, Bélisle, Bourget, Cameron, Desruisseaux, Grosart, Hays, Kinnear, Lamontagne, Lang, Leonard, MacKenzie, O'Leary (*Carleton*), Phillips (*Prince*), Sullivan, Thompson and Yuzyk.

After debate, and—
The question being put on the motion, it was—
Resolved in the affirmative."

20678—1½

Extract from the Minutes of the Proceedings of the Senate, Thursday, September 19th, 1968:

"With leave of the Senate,

The Honourable Senator Lamontagne, P.C., moved, seconded by the Honourable Senator Benidickson, P.C.

That the name of the Honourable Senator Robichaud be substituted for that of the Honourable Senator Argue on the list of Senators serving on the Special Committee on Science Policy.

The question being put on the motion, it was—
Resolved in the affirmative."

Extract from the Minutes of the Proceedings of the Senate, Wednesday, February 5th, 1969:

"With leave of the Senate,

The Honourable Senator McDonald moved, seconded by the Honourable Senator Macdonald (*Cape Breton*):

That the names of the Honourable Senators Blois, Carter, Giguère, Haig, McGrand and Nichol be added to the list of Senators serving on the Special Committee on Science Policy.

The question being put on the motion, it was—
Resolved in the affirmative."

ROBERT FORTIER,
Clerk of the Senate.

MINUTES OF PROCEEDINGS

FRIDAY, June 27, 1969.

Pursuant to adjournment and notice the Special Committee on Science Policy met this day at 10.00 a.m.

Present: The Honourable Senators Lamontagne (*Chairman*), Bourget, Carter, Grosart, Robichaud—(5).

In attendance:

Philip J. Pocock, Director of Research (*Physical Science*).

The following witnesses were heard:

The Sheridan Park Association: Dr. M. Grace, General Manager, Dunlop Research Centre. Mr. A. J. Wellington, Manager, Product Research Centre, Cominco Ltd. Mr. W. R. Stadelman, President, Ontario Research Foundation. Mr. Donald Holland, Director, R & D Program, Department of Trade and Development, Province of Ontario. Mr. Bruce Hewat, Vice-President, Sheridan Park Association.

(*A curriculum vitae of each witness follows these Minutes*)

The following is printed as an Appendix:

No. 187—Brief submitted by The Sheridan Park Association.

At 12.05 p.m. the Committee adjourned to the call of the Chairman.

ATTEST:

Patrick J. Savoie,
Clerk of the Committee.

CURRICULUM VITAE

Hewatt, Bruce M.—born Toronto 1924, only son of Andrew Rutherford Hewatt and Elizabeth Mundell Hewatt. He attended the John English public school and Mimico High School. After leaving school Mr. Hewatt volunteered for military service and spent the years 1943-46 in the Royal Canadian Air Force. After being honourably discharged Mr. Hewatt accepted a temporary position with the War Assetts Corporation following which he joined the British American Oil Company, now Gulf of Canada. His responsibilities as Director of Services in the Research and Development include mechanical engineering, personnel, accounting, information systems, patents and other administrative responsibilities. Mr. Hewatt married the former Helen Louise Dinney, they have 3 children, 2 boys and 1 girl presently at school. Mr. Hewatt is currently Vice-President of the Sheridan Park Association, President of the Kiwanis Club of Dixie and a member of the Advisory Council of the Toronto Business and Professional Women's Club.

Holland, Donald Edwin.—Mr. Holland was born in Thorold, Ontario in 1923. He attended primary and secondary schools in that town. At the age of eighteen he volunteered for the Royal Canadian Air Force and served as a tail gunner in the European theatre of operations. He retired after the second world was as a Flying Officer. Mr. Holland then attended the University of Toronto for three years in the Pass Arts Course. The following year he took the Industrial Relations Course at Queen's University. After leaving Queen's Mr. Holland joined Dun & Bradstreet, starting in the Credit Department and later in the Financial Reporting Department. Mr. Holland began his Ontario Government career as an Industrial Consultant for the Trade & Industry Branch of the Department of Planning & Development in 1953. Two years later he was posted to Chicago as Industrial Commissioner representing the Government of Ontario. In 1957 he returned to Toronto as Assistant to the Director, and in 1962 was appointed Deputy Director of the Trade & Industry Branch. Currently, Mr. Holland is Director of R & D Programs for the Ontario Department of Trade & Development.

Grace, Norman S., General Manager, Dunlop Research Centre, Sheridan Park, Ontario.—*Born:* Naini Tal, India, August 15th, 1906. *Technical Training:* B.Sc. (gold medal) & M.Sc. Chemistry, University of Saskatchewan 1927 and 1929; Ph.D. London 1931. Post Doctoral Fellow University of California, Berkeley 1931-33. Physics Department, University of Toronto, 1933-35. *Professional Career:* Research Chemist, Gutta Percha & Rubber Co., Toronto, 1935-37; Research Chemist under Dr. G. S. Whitby, National Research Council, Ottawa, 1939. With Dunlop since 1939 starting in laboratory and plant process control; Chief Chemist 1940 on leave majority of time 1942-44 to Canadian Government Synthetic Rubber program, nine months Washington representative; remainder Manager, Technical Service Division, Polymer Corporation, Technical Superintendent, Dunlop Canada Limited, 1945-54. Present position since June 1954. *Activities:* Chairman Ontario Rubber Group 1940-41, 1941-42; Chairman Toronto Section CIC 43-44, Chairman Exhibits Committee Chemical Conference

1944; CIC Councillor "A" 1945-48, CIC Councillor "B" 1954-57, First Chairman Division of Rubber Chemistry, CIC, 1945-46. Member, National Research Council Committee on Synthetic Rubber Research 1945-52. Founding member and Past Chairman, Canadian Research Management Association; Company representative Industrial Research Institute, New York, Chairman, Ontario Research Community Organizing Committe 1960-61. Director and Past President, Sheridan Park Association, Director, Sheridan Park Corporation. Chairman, Chemical Engineering Sub-Committee, Queen's University Engineering Advisory Council. Past Chairman, Division of Rubber Chemistry, ACS; first Canadian to hold this position. Participated in first seminar on "Management of Industrial Research" sponsored by IRI at Harvard Business School in 1959. Life member Ontario Rubber Group. President, Chemical Institute of Canada. Member, Board of Governors, York University, Toronto. Member, Research & Development Committee, Canadian Chamber of Commerce. *Extra Activities:* President, Oneida Country Club, Port Credit, Ontario. Founding Director Toronto Striders Track Club. Past Warden, Church of the Redeemer, Toronto. *Honours:* Fellow, American Association for the Advancement of Science. Fellow, Chemical Institute of Canada. Fellow, Institution of the Rubber Industry of Great Britain. *Family:* Two sons, one daughter. *Interests:* Fishing, hunting, golf, tennis, hockey.

Stadelman, William R.—Born in Shakespeare, Ontario, he subsequently attended the University of Toronto, graduating in chemical engineering in 1941. Later, he attended the Wharton School of Finance and Economics, University of Pennsylvania, obtaining his M.B.A. in 1949. Since 1941 he has held several engineering and technical administrative posts in industry, both in Canada and the United States. In 1950 he joined the Ontario Research Foundation as Secretary-Treasurer, eventually assuming responsibility for all administrative functions of the Foundation. In 1964, Mr. Stadelman was appointed President of the Foundation, the position he currently holds. He is a member of The Ontario Economic Council and of various technical committees and associations, and is the current past-president of the Sheridan Park Association.

Wellington, J. R.—J. R. Wellington graduated in 1942 with a B.Sc. in Chemical Engineering from the University of Saskatchewan. After a period of service in Europe with the Canadian Army, he joined Cominco in 1946. He has held a number of positions in Cominco's Research and Development group and is presently Manager, Product Research, in charge of Cominco's Product Research Centre since its establishment at Sheridan Park, Ontario, in 1964. He is an active member of various technical societies, and was President of the Sheridan Park Association, 1964-66.

THE SENATE

SPECIAL SENATE COMMITTEE ON SCIENCE POLICY

EVIDENCE

Ottawa, Friday, June 27, 1969

The Special Senate Committee on Science Policy met this day at 10 a.m.

Senator Maurice Lamontagne (*Chairman*) in the Chair.

The Chairman: Honourable senators, we have before us this morning representatives of the Sheridan Park Association. This is a happy occasion, gentlemen, because it is the last of our public hearings. As you say in your brief, your experience is unique in Canada, and we will be very interested in hearing more about it. This applies more to my colleagues on the committee than to myself because I have had the privilege of visiting Sheridan Park, and spending a day and a half there in January, when it was much colder than it is today.

Without any further introduction, I will ask Dr. Grace, as Past President of the Sheridan Park Association, and one of those who initiated the project together with the Ontario Research Foundation to open the proceedings.

Dr. M. Grace (Past President, The Sheridan Park Association): Thank you very much, Mr. Chairman. Honourable senators, it is a pleasure for me personally to come before you again, and it is a particular pleasure to come with four other members of the Sheridan Park research community, Canada's first industrial research park, and talk with you about this important activity. Three of us are past presidents of the Sheridan Park Association—Mr. Wellington from Cominco, Mr. Stadelman of the Ontario Research Foundation, and myself from Dunlop. We are joined by Mr. Bruce Hewat of Gulf Oil (Canada), who is the current vice president of our association, and Mr. Donald Holland of the Sheridan Park Corporation.

The Chairman: He might also be called a member of the staff of our committee.

Dr. Grace: In keeping with the community spirit, we have divided up our initial presentation. We are co-operating. I will start by dealing very briefly with the philosophy leading to the creation of the research community.

Mr. Wellington will compare Sheridan Park with other leading research parks in the United States, perhaps pointing out major differences as well as similarities.

Mr. Stadelman will give you some indication of what has been accomplished, after which all five of us will be happy to try to answer any questions you may wish to raise.

I will now give the philosophy, and a little bit of the history, of the Sheridan Park Research Community. The general philosophy and thinking that gave rise to the Sheridan Park Research Community started more than ten years ago. However, I believe that the reasons for its creation are not only valid today, but many of them are now even more persuasive.

While, as you well know, industrial research has been an important factor leading to the rapid and accelerating rate of change that is going on throughout the world, it has not remained unaffected by these changes. There has been a continuing trend to greater complexity, higher costs, and larger risks.

In Canada these trends have been accentuated by many factors with most of which you are familiar: for instance, the small size of many of our industrial research operations; the higher cost of research equipment, most of which is imported, as you have heard; lack of well organized information services—I understand that last night you had a presentation on information services for Canada, which is very important—and an inability to attract a fair share of our best minds into industrial research.

This is indeed a sobering situation, one of great concern to the leaders of Canadian

industry. It has resulted in much critical reappraisal and led to the conclusion that the precise location of a research laboratory is an important factor influencing both its costs and chances of success.

In general, two quite different types of location are preferred—each has its advantages. The traditional location, adjacent to a major manufacturing unit, assures operation in a highly industrialized atmosphere. On the other hand, a location divorced from manufacturing, deliberately placed in a scientific and technical environment, such as in an industrial research park, is at the other end of the spectrum of possibilities.

The latter philosophy, having particular reference to our developing Canadian situation, gave rise to the Sheridan Park Research Community. The idea was originally suggested by Dr. Westman of the Ontario Research Foundation, but industry itself backed the idea and has played a leading role in its formation, operation and subsequent development. It was hoped that by locating a number of separate industrial research laboratories adjacent to the broadly based, highly industrially-oriented Ontario Research Foundation, we could create a community with a prestige scientific and technical environment that would attract top-flight staff and promote an increasing measure of co-operation; that in this environment, through symposia, conferences and personal contact, the staff could more readily keep up with the rapidly advancing front of science and technology; that it would be possible to get rapid and competent advice because of the wide group of scientific and technical disciplines represented; that access to a very broad spectrum of modern research and development equipment could, by mutual arrangement, be available; that advanced library and information services could be developed within the community and have direct contact with future federal services.

I would like to read a brief statement of the main objectives of the community association that operates the community.

> The Sheridan Park Research Community was established in January, 1963, for the purpose of creating at Sheridan Park an outward and forward looking centre of excellence dedicated to the efficient prosecution of creative industrial research and development. The purpose of the Sheridan Park Association is to assist the community in achieving and fulfilling its particular purpose and to establish, maintain and operate appropriate community facilities in the interests of the member companies.

I will not give a lot of credits. Many people, many organizations, various aspects and various factors of government have been associated with the creation of Sheridan Park. Without a lot of dedicated effort it would not have become the success it is.

In conclusion, I might mention that I have one or two pictures of the park. They are not complete but they show some of the laboratories. I am sorry I could not bring an adequate picture, but perhaps this might be passed round to enable the honourable senators to have a view of the park.

I will now ask Mr. Wellington to deal with the relationship of Sheridan Park to some of the leading American parks that we have visited.

Mr. A. J. Wellington, Past President, Manager, Product Research Centre, Cominco Limited: Mr. Chairman, honourable senators: it is a pleasure to be here today on behalf of the Sheridan Park Association, as one of its past presidents, to tell you something about the Sheridan Park research community as it might compare with some of the research communities of the United States, some of which you have heard about and some of which you may have visited.

As has been mentioned, the Sheridan Park research community is unique in several ways. It is Canada's first and, so far, only integrated community devoted to applied research and development. It is unique in that it is wholly devoted to research and development, which is unusual even for North America. There are very many so-called research and research and industrial parks in North America, but virtually all permit or encourage some degree of manufacturing, usually light or technologically based industry.

In terms of physical characteristics, Sheridan Park is about average as parks go. There are 350 acres, nine occupants, 1,600 employees and a $34 million investment in buildings. Two of the better known research parks in the United States are the Research Triangle in North Carolina, which has 5,000 acres and a dozen occupants; the Stanford Industrial Park in California, which has 700 acres and 60 tenants; and the Route 128 area surrounding Boston has a number of research and

industrial parks, and appears not unlike the 401 area surrounding our own Toronto.

Research parks are a relatively recent phenomenon. In 1964, for example, it was reported that 50 per cent of the parks in existence in the United States were only three years old or less. It was also reported that 50 per cent had an occupancy rate of only 20 per cent to 30 per cent, and that one-fifth were unoccupied. Happily, at Sheridan Park, with 250 out of 350 acres sold we can report an occupancy rate of 70 per cent.

Some of the factors affecting the development and usefulness of a research community are: (1) location, (2) incentives, (3) university liaison, (4) community relations.

Location is both the greatest attraction and the most important contribution a research park can make to the industries established in it. Location has many interrelated aspects concerned with geography, site selection and services, as they affect the physical plant and the social, residential and educational factors as they affect the staff. Some of these may seem rather mundane points, but they are very important to someone who is making a commitment for a building and enterprise which will be there for many years. Under location, accessibility to all normal forms of transportation, in particular to a large international airport, is a first consideration. This would suggest, if not limit, suitable locations to the vicinity of our larger cities.

Dealing with the second point, incentives, a couple of years ago Dr. Grace and I visited the three research parks in the United States to which I referred earlier, and noted that none had any form of financial assistance or core facilities to offer companies locating there. In fact, we could say that the reverse was true. However, a review of the history and development of these other centres suggests that the provision of suitable core facilities can provide a strong incentive in the development of a park. Sheridan Park has been fortunate in having the Ontario Research Foundation as a core technical facility. Within the last year, through the joint effort of the Sheridan Park Corporation (which is a crown corporation of the provincial government), and the community members, a conference centre has been established in Sheridan Park to help foster and develop the communities' internal and external relations. There are, as you know, no federal Government incentives applicable to research parks as such at the present time. We might suggest that one possible way in which the federal Government could encourage research communities would be to consider such areas as possible sites for new or expanded federal R & D facilities, and also for the location of information disseminating centres, which might also include appropriate conference facilities.

My third point was university liaison. University liaison is a matter of deep concern to all research organizations. Canadian industry in general has not in the past had very strong ties with universities, and vice versa. Although our visits to the United States were of necessity brief, and even superficial, the overall impression gained is that close interaction between the universities and the industry has had some very desirable end results. However, in Sheridan Park, with the type of organizations located in that park, with the kind of facility and programs these organizations have, and the close proximity to a number of universities, there is a great opportunity for Sheridan Park and its member companies, together with the surrounding universities, to explore and foster closer university-industry liaison, new for Canada. I think the existence of a multi-company industrial R & D complex such as Sheridan Park, provides a strong focal point for contact.

My fourth point was community relationships. Sheridan Park is also unique in its community concept. The thought that the member companies might work together to create the desired environment and necessary communal services, is unusual and implies a responsibility on the part of the members for the success of the community. This is the primary purpose of our association which, as you know, is made up of senior management personnel from each member company. Its aim is to assist the community in achieving and fulfilling its purpose and to establish, maintain, and operate appropriate community facilities in the interests of the member companies. The association is thus the means by which the member companies approve and set in motion measures of mutual interest for the development of the community Also of great value is its function in bringing together a large number of knowledgeable people and in developing an appreciation of each other's special abilities. Being personally acquainted, and also conveniently nearby, makes it easy for them to seek advice from one another with the utmost informality. Sometimes useful help can be given to someone in another field of endeavour with very little effort.

Occasionally, such inquiries may blossom into technical developments which are mutually advantageous to all concerned.

As far as I know, no other research park is quite like Sheridan Park; no other research park has chosen to call itself a community. It is perhaps a uniquely Canadian attitude. Perhaps this attitude is made necessary because of the small size of our country compared with our highly populated and industrialized neighbour to the south: a stimulus which gives rise to the concept that by acting together in concert we can achieve the results we desire more efficiently, more economically and more completely. This is a philosophy of the founders and the members of Sheridan Park that has guided, is guiding and I hope will continue to guide its affairs in the future.

Dr. Grace: Mr. Stadelman will discuss the current program of the company.

The Chairman: He is the immediate Past President.

Mr. W. R. Stadelman, Past President, Sheridan Park Association, President, Ontario Research Foundation: I am going to outline the sort of thing the association does which will give you perhaps a better insight into what the community aspect of our operations consist of. I do not think there is any doubt but that the association has played a most useful role in the operation of the mutual facilities of the community and that its activities have been of real benefit to the company. By mutual facilities I mean the parklands and the conference centre. We all pay dues to the association.

It is becoming quite clear that the Sheridan Park research community is becoming, if it has not already become, a focal centre for those corporations, individuals and organizations who are interested in industrial research and industrial technology in Southern Ontario. The community has brought attention to Canada and to Ontario from all sections of the world. It has been visited by senior scientific personnel from Australia, New Zealand, Japan, USSR, Yugoslavia, Czechoslovakia, France, Italy, Great Britain and the United States. Indeed, the OECD report on research and development in Canada states, "Canadians have every reason to point with pride to the research group which has been established at Sheridan Park." This is the conference centre which you have mentioned.

The Chairman: You have seen the report of the OECD? It has not been published yet.

Mr. Stadelman: It has not been published, pardon me. The conference centre was opened in November. By the end of April it had posted 65 different meetings and involved 5,000 people. There is no doubt that it has provided a very necessary focal centre for the community itself.

The commercial complex, within the park, is operated by private commercial interests. In it are housed the IBM data centre, a consulting firm, a bank, hairdressing establishment, a barber shop, restaurant, dental offices, and a travel agency. The purpose of the association has been outward-looking as well as inward-looking. We have tried to make it an industrial centre for research and technology serving the industrial community in Southern Ontario. With this in mind, the association wrote to 130 companies in the immediate area advising them of what we were trying to accomplish and asked if they were interested. About 75 per cent specifically requested that they would like some mutual and continuing method of communication with us. As a result we have a very special mailing list of 150 representatives of 100 industrial firms and 12 universities and educational institutions with whom we are communicating and inviting them to our lectures. The association has been a host to a number of special conferences and meetings. Two years ago it was a host of the Fifth Annual Conference of the Research Management Association. This spring it was the location for a meeting of industrial research managers who met to discuss with government officials, government incentives for industrial research and development. This conference was particularly successful and I believe unofficial submissions were made by that group of people to this committee. The third Canadian fuel seminar was held there in February. The Science Council of Canada met in the community in May of 1968. The OECD held their meetings on their audit of research and development in Canada at Sheridan Park for those areas of Southern Ontario. There have been a number of various technical organizations that have met there. The Electro Chemical Society, the Proprietary Association—that is the technical drug manufacturers—McMaster University held an inorganic chemistry meeting at the centre. Indeed, your chairman, Senator Lamontagne, inaugurated what we

call our prestige lectures this January by talking to us on Canadian science policy. We intend to keep this up.

The Chairman: Senator Grosart does not have a monopoly on prestige lectures.

Senator Bourget: Even in your own province.

Senator Grosart: I give the joke lectures.

Mr. Stadelman: We intend to keep up this concept of prestige lectures in which we invite all the interested people to attend.

The association prepared a tax brief and presented it to the Ontario government regarding municipal business taxes and sales tax as it concerns research and development activities. Although this brief was put together by the association, I should like to point out that this brief of the association was supported by a number of private companies outside the association, such as Northern Electric, Imperial Oil, Dupont of Canada, W. R. Grace and Company, Canadian Breweries, and Duplate Canada.

I should like to talk briefly about the technical co-ordinating committee which I suppose is the real guts of the community activities. This co-ordinating committee maintains skills and facilities index of the community. This index lists the various skills of the member companies as well as listing the scientific equipment available in these companies. This committee also maintains a library list of serials for the research community and it keeps these two inventories up to date. If you wish to know if a certain serial is available you just need to check this list of serials or perhaps it is in one or other of the libraries of our colleagues.

Informal and formal seminars were arranged, including programs in combination with university staffs. For example those people interested in infra-red spectroscopy techniques will meet to discuss how it relates to their work.

The more formal seminars included lectures by Dr. Mary Thomson on "Specific Ion Electrodes," Professor D. R. Wiles of Carleton University on "Atomic Recoil Reactions and Their Possible Uses," and Professor S. Sandler of the University of Toronto on "Advances in Opticometric Methods of Chemical Analysis".

Educational courses for the staff of member companies in computer programming and effective reading were arranged. These have been particularly popular. For instance, we have had the introduction to computer technology courses, effective reading courses, and these have been particularly effective. This fall we are arranging a symposium on material science, "New Concepts in Materials", and this is a very important aspect today in applied research.

This conference will be held in October within the park. It is being arranged by the park itself and will include speakers from Europe, Great Britain and the United States.

The association made arrangements with the National Science Library for member companies to participate experimentally, for a period of several months in the computerized SDI system operated by the National Science Library. Under this arrangement, each company received computer print-out sheets listing current titles of papers in selected areas of interest every two weeks. These were sent to individuals in the park. Following this experimental period, eight of the nine member companies made arrangements with the National Science Library to continue the service of a fee basis. The companies are paying the library for the service rendered to them.

From a technical viewpoint, the operations of our staff relations committee are not too important, but they are particularly important to the member companies because it brings about good employer relationship. We have a soccer league, a baseball league, a hockey league and, quite recently, we had a very successful picnic.

Senator Bourget: You have no golf?

Mr. Stadelman: Yes, there is a golf league and a curling league too. This is very important as it is good for the staff and it also brings people, shall we say, in Mr. Wellington's organization into contact with those in my organization. Mr. Wellington and I can say we want to co-operate, but co-operation does not exist at that level. It is just when an employee who is working at the bench in Mr. Wellington's laboratory talks with an employee working at the bench in my laboratory. That is effective co-operation. All that Mr. Wellington and I can do to bring about such co-operation is make the surrounding conditions which will allow it to happen. That, honourable senators, is, very briefly, the sort of thing the association does. I would be very pleased to answer any questions.

The Chairman: Thank you. As I said before, we have been speaking during the last

few weeks about the isolation which exists in the scientific community in Canada, including the isolation of scientists within industry. We have now a good example, but perhaps, as you say, a unique example, of co-operation.

Senator Carter: Mr. Chairman, Dr. Grace enumerated a lot of advantages of this arrangement of having a rich community gathered together in a particular spot. Nine different companies carrying on nine different lines of applied research are involved. But there must be some disadvantages. Some of the witnesses we have had, and some science writers, have emphasized the point that applied research and development should be carried on as close to the production line as possible. You have abandoned that. You have traded it off for something else. Also, there has been the idea that this type of thing should be, if possible, in fairly close proximity to universities, but you are still half an hour away or possibly longer from some universities. Can you tell us whether there are disadvantages that I have missed and if the ones I have mentioned are significant compared with the great advantages that you have from this particular arrangement?

Dr. Grace: You have raised a very good point. As I indicated in my opening remarks, there are these two extreme points. One is to locate in, shall we say, the shadow of the factory smokestack, and the other is to locate well away from there. Now, in our own company we have around the world six or seven related central research laboratories working on over-all company problems. They vary in location from being very close to the factory smokestack, to the other extreme. With our own laboratory at Sheridan Park we are probably the furthest away from operating under the smokestack or at the factory site. All in all, we are pretty central, if you like, from other standpoints.

One of the dangers of being on the factory site is that when there is a fire—and that is the term we use for any emergency, and there are plenty of those in certain operations—it is a case of all hands to the pumps. So there is a danger of what we might call the seed wheat, the really small group of people charged with the responsibility of looking into the future, trying to protect the future of the company, being involved or diverted too frequently. Secondly, when they are not diverted on an instantaneous basis, they are often directed to very short-run sets of problems. You must not neglect the short-run and you must be able to put the fires out. So that, if you have an adequate protective team at the factory to put the fires out then you need probably a short-run development group at the plant to keep incremental changes going. A lot of improvements are incremental. They are small. Then the philosophy is that you need another group, more detached, to look further ahead and try to see where a company's interests must be protected and try to work in those areas.

Perhaps others would touch further on that.

Mr. Wellington: There are various advantages and disadvantages, and trade-offs must be made. For instance, it is unlikely that we would ever move our process research away from right along side the plant to a totally different sort of environment. The particular activity we have in Sheridan Park is product research. It is there rather than at the plant, because it is in the centre of the consuming area where there can be a greater interplay and interchange with the people who are going to use the products which we develop. So that every case might have to be individually considered. I might just mention a couple of fears that people had about coming into research communities which might be thought expressed from time to time. One is that of stealing of staff which in the case of Sheridan Park I would say has not happened. People worry about this as a disadvantage, but it has not been a problem in practice. Another one that people worry about sometimes is security, but I cannot see this as posing any great problem. Of course one can have security problems in some areas while you have patent applications pending on proprietary processes. On the other hand there are some things that you are doing that you will want to talk about. Most of us are in the business of helping our customers and so we are anxious to talk about what we are doing.

The Chairman: The fact that you are not really competing amongst yourselves and that you are different companies must minimize this danger too.

Mr. Wellington: Yes, although I am told that the Warner Lambert people have gone on record as saying that they would invite another drug company into the park.

Senator Carter: How do people get into your association? You started out with four companies some years ago and now you have nine. Do you invite them in or have you any applications pending? If the idea behind this

is good, it is growing fairly slowly. What is the reason for that?

Mr. Stadelman: To become a member of the association is very simple. All you have to do is own land within Sheridan Park Research Community, and if you do that you may join the association if you wish. If you buy land within the community and you want to join the association, you are automatically in. We are trying to extend this by having two levels of membership. The first depending upon land ownership where you pay the fees to maintain the grounds and so on; and then you would have a membership for people who wanted to remain in contact to perhaps attend lectures that are held. In this case the fee would be nominal. I imagine if we get two dollars to pay mailing expenses and things like that, that is about all we would be interested in.

Senator Bourget: Have land prices gone up there as much as elsewhere?

The Chairman: As I understand it, they have owned the land since the very beginning.

Senator Bourget: But if somebody would like to buy a lot today and build facilities, would the price of the land be much higher than it was five years ago.

Mr. Stadelman: It is higher; I could not be specific about the prices but Mr. Holland may know. My understanding is that the Ontario government furnished sufficient funds to buy the remaining land, and now there is no other cost except interest costs increasing the price of the lands as time goes on. But this is something that every developer is faced with.

Senator Bourget: Is the area completely separate from the city?

Mr. Stadelman: The town of Mississauga? It is located in the town of Mississauga and it is not separate from the municipality.

Senator Bourget: You have to pay taxes to the municipality?

Mr. Stadelman: That is right.

Senator Bourget: Do you build your own facilities like sewers and water mains?

Mr. Stadelman: No, that was the agreement with the original developer. We all bought fully-serviced land from the developer. The services are owned by the municipality as they are in any other municipality.

Mr. Donald E. Holland, Sheridan Park Corporation: In reply to Senator Grosart's question so far as the cost of the land is concerned, as Mr. Stadelman mentioned Sheridan Park Corporation is a crown corporation which was established by the Ontario Government. After the developers had developed part of the land a corporation was set up to sell off the remaining portion of the land. There were 350 acres with some sold off and more to be sold. The Province of Ontario was a little concerned about the problem of finances, but then, we are all always interested in the problems of finance, on the principle that part should be self-liquidating so that any funds expended on the Park would be added to the expenses of servicing and interest. Having said that, the corporation and the Department of Trade and Development as such would not, I think, be critical of losing a company to the park if that company thought the price of land was too high.

Senator Grosart: Mr. Chairman, for the record I would like it to be made clear that that was Senator Bourget's question and not mine. As you know, Mr. Chairman, I always await the call of the chairman.

Senator Bourget: Well, it is team-work anyway.

Senator Carter: When you put a group of labs together in a community like you have in Sheridan Park you should have benefits from interaction or communications among the different scientists and the different technicians. Mr. Stadelman told us about the recreation facilities and the golf and the fact that they get together over meals. This committee has been told that most innovations arise out of personal contacts like that. Have you conducted any studies at Sheridan Park to see if any innovations have actually emerged in this fashion?

The Chairman: More precisely the diffusion of knowledge.

Senator Carter: Between the different people.

Mr. Wellington: We have not made any studies.

Senator Carter: Just dealing with the interplay or the inter-action of personal contact between technicians and scientists. You may have, for example, one technician working on one problem and another technician working on another.

The Chairman: For example, somebody may have a problem in one section and may get the solution from another person through this personal contact.

Senator Grosart: MIT has documented instances of this.

Mr. Holland: This has not been done with us.

Mr. Wellington: Senator Carter was asking for our experience. The only case I can think of personally, and maybe the other members would care to comment on this, is where members of our staff in chance contact have picked up ideas. But there is no set pattern at this time.

The Chairman: Have you any experience of that kind, Dr. Grace?

Mr. Bruce Hewat, Vice President, The Sheridan Park Association: I think that Gulf Oil has been successful in developing a number of rubber process oils. I think that to some extent this is due to the relationship between the people at Dunlop and the people at Gulf. Our company have been trying to develop suitable oils for a number of years. I think it is unquestionably the relationship with Dunlop that allowed us to do this.

Senator Bourget: I think you gave some examples in your brief. I think you gave one example, at least, and that is the very one.

Mr. Wellington: There is another example where the Mallory people learned useful information from Cominco. The research director from Mallory and one or two staff came over and talked to us about zinc dust, and from what they learned they were able to put it together and do something new, from their point of view. I thought your original question related to the pattern of how it happened. I do not know that there is a pattern of how it happens.

The Chairman: These have to be more or less accidental.

Mr. Holland: But would they have happened if they had not been working in association?

Senator Grosart: Not really. MIT told us that this had developed on Route 128 to the point where the engineers stopped reading.

The Chairman: I think one of the points they were raising was the transfer of knowledge through personal contacts happened more within a company than between companies. It happens between companies, but more specifically within a company—according to the figures I remember, at least, and I may be wrong.

Senator Grosart: Yes, they did say that. It is my recollection that they made the other point very strongly, where they said you had people saying, "You do it that way; we do it this way." So perhaps somebody said, "I know a fellow who is doing it another way." They told us this was really the vital chain of communication in moving research into the innovation stage.

Dr. Grace: Very generally, the opportunity is there for each of the participants to co-operate as a laboratory or for individuals to co-operate with any of the other people in the Park. We have taken advantage of it, and we have enjoyed co-operating with all the groups represented here and with other laboratories. So far none has been of the nature where we can shout, "Eureka!", that we have really made a big find because of it, but we have made valuable progress. We wanted iron-free sulphur a few years ago, and Gulf made a special point of cutting into their local sulphur plant to give us low-iron sulphur.

A few years ago there was interest in remote access time sharing of computers, and Mr. Wellington was one of the first people in the Park to put it in. He said, "Would you like to come over and try one or two of your problems?" We found we could save more than the time and the price of the technician, so we put one in. We tend to be more advanced on this advancing edge because of someone having experience. I could go on with each of the other laboratories, but unfortunately there have not been any big things yet, but I think they will come.

Senator Grosart: Are you doing anything to make them come?

Dr. Grace: Yes. One of the things we always wanted was this local conference centre, which we got in November 1968, and associated with it is a very modest cafeteria. Most of the original participants did not put in a cafeteria and have been getting by with lunch rooms and the like. The hope was to get people together. So, we have this focus around the central conference room and the cafeteria, and we have forward plans for a number of years ahead to go much further in the way of a science conference information technical centre. We do not know what it is

going to be like in four or five years, but we have a very definite policy that we are going to put a forward-looking and competent facility in there; and, again, it will be one in which all the participants can take part.

The Chairman: Did you find at the beginning that people of different companies were a little reluctant to talk to each other?

Mr. Wellington: I do not think they were reluctant. I think you have to provide the opportunity and if you have no common meeting ground, you come to work and go home.

Senator Bourget: Do you often have that kind of technical information conference or meeting between the companies located on your site?

Mr. Wellington: I did not hear the first part of your question.

Senator Bourget: I am asking you if you very often have conferences between the technical people of different companies who are located on your site. Do they meet very often to exchange ideas?

Mr. Wellington: I think Senator Lamontagne put his finger on a point a little while ago, when he noted that the companies that are in Sheridan Park are quite diverse and work on quite different things. But we did have a series of meetings or conferences for people within the park on instrumental techniques, for one thing. That is the kind of thing all the labs would be involved in, where we would each have people who were doing this kind of operation—like X-Ray diffraction, and so on.

Senator Bourget: Those who are there do have meetings together, opportunities to meet in conference or at meetings, to exchange technical knowledge?

Mr. Wellington: This particular set of meetings was organized at that time for the people within the park.

Mr. Stadelman: To exchange technical views on a particular analytical technique.

The Chairman: This is just the beginning,

Senator Bourget: I know, but when you were there, Mr. Chairman, it was a public meeting. Not only those who are located there were invited, but, I imagine, also some other people from outside.

Dr. Grace: It was so important we invited a number of others.

Senator Bourget: My question was: Those who are there, do they have weekly or monthly meetings to exchange ideas?

Mr. Wellington: They are usually organized for some specific purpose, and in many instances for people within the community, like the meeting you referred to this fall. The materials meeting is being organized by the people in Sheridan Park and the universities as a public meeting.

Senator Bourget: I thought that could be one of the advantages that it might offer to the science community to exchange ideas, to talk together.

The Chairman: You have at the end of the brief a kind of list for the month of April for all these activities, the showing of films and lectures.

Mr. Holland: This does go on regularly.

Mr. Stadelman: From a management point of view, you do not take one from this group and one from that group, and take them by the scruff of the neck and say, "Exchange!" You have a golf tournament and discuss infra-red spectroscopy. You have computer staff lectures. We find things out in the odd minute when we are having a smoke or a cup of coffee. You create this milieu for the exchange and facilitate it; then you sit back and let it happen. If you put technical people together, they get on to some subject and they just cannot refuse to exchange views; this is their life.

Senator Grosart: Dr. Stadelman, you are postulating two choices, and there are many in between. A gap I would see—and I am fully aware your experiment is new—is that we have not had any evidence yet about what you are doing at the employee level. Let me ask you a specific question. Have you made any systematic analysis of the similarity of jobs, lab jobs, as between the different companies? Have you said, "Here we can find a group of 20 people on the same kind of bench"? Or, "Here we have 30 people doing more or less the same kind of computer program at low income levels."? Have you made a systematic analysis?

Mr. Stadelman: In the general Toronto area, if you are talking about the decision of setting wage rates, a number of industrial companies have gotten together for years.

Senator Grosart: I am not talking about wage rates in R & D.

The Chairman: You are talking about work done that would be similar from one company to the other.

Mr. Stadelman: I do not understand the question I am afraid.

Senator Grosart: I could repeat it, but perhaps I suggest you read it in the record. It was a simple straightforward question. I merely asked you if you made a systematic analysis of the groups of people doing common work in R & D. I do not know any other way to put the question.

The Chairman: There must be quite a number of people working on computers for the service of their individual company. This must happen also in other companies where you have people doing basically the same work.

Mr. Stadelman: Do they get in touch with one another, yes.

Senator Grosart: My question is have you made an analysis to determine whether there do exist groups within the Sheridan Park complex? It is a simple question.

Mr. Stadelman: Yes.

Dr. Grace: We have not pushed it as far as your question suggests. We will think about that.

Senator Grosart: This is being done very successfully in Europe.

The Chairman: You have quite a number of chemists. I am sure there are chemists in other companies also.

Mr. Holland: The answer to Senator Grosart's question is no, there has been no survey or systematic study done. The direct answer is no. I think it has happened by inference or practice, but not a special study to see how many different types of groups are in the park.

The Chairman: You have not yet started to consider the possibility of having joint research services. You are having these joint meetings and seminars, but you have not yet started to consider the possibility of joint services for all interested companies.

Mr. Stadelman: This has happened to a certain extent. Gulf has done certain analyses for other companies.

The Chairman: These are exchanges.

Senator Grosart: The reason I asked the question is that recently in the computer field some very interesting discoveries were made involving about 30 stenographers who were doing nothing but typing a program. Very substantial savings and efficiency gains resulted. One stenographer said "I do it this way" and another said, "I do it this way." Another said, "I use this kind of chair; I used to use another one." This is the kind of thing I am talking about.

Mr. Stadelman: Those sort of conferences or meetings have occurred in the analytical technique area.

Senator Grosart: I suggested it, because I have had something to do over the years with labour personnel problems. One thing I discovered is that there is nothing better than making them all think they are managers.

Senator Carter: I have one more question. Last night we had witnesses discussing the importance of a national data bank and better management and dissemination of scientific and technical knowledge. I gathered from what Mr. Wellington said that you have a miniature information centre of your own in the Park which serves all the companies. Is that correct? I should like to know how it works. If it does not work too well with you people there is not much chance of it working on a national scale.

Mr. Stadelman: I think the experience we have had with the National Science Library on current awareness profiles of computerized information has been very good. Eight of the nine companies are paying for the service now from the National Science Library. All of us have our own libraries but probably the one at the Foundation is the most extensive. It is open to anybody.

Senator Carter: Each of the nine companies has a library of its own?

Mr. Stadelman: Yes.

Senator Carter: You have a reference centre somewhere?

Mr. Stadelman: That is right.

Senator Carter: I am thinking of page 9 or 10 where you are talking about an index of skills and facilities available to all member companies and available to all companies

shared in the experimental programs of the National Science Library. Page 10, second paragraph:

> A national information network has been recommended by the Science Secretariat and is a technical possibility now. Sheridan Park can be an important link in that network...

I should like a little more information as to how this is working and what the experience has been. I am rather surprised that you still find it necessary to have nine separate libraries instead of one.

Mr. Stadelman: I can answer that briefly by saying that undoubtedly the people in Dr. Grace's laboratory are very interested in the technology of rubber, and they will want to be in almost continuous contact with those journals that are germane to their particular activities. They are not ones to sit in mausoleums some place, but want to use it from day to day. That is the type of thing maintained within the individual company library.

Let us take, for instance, the Journal of Leather Science. Nobody in the group is directly concerned with leather, but it may be one of the journals that one should have on hand for the very occasional reference made to it. For those journals that are remote we look to the National Science Library to have it. If there is a reference that we want, we get in touch with them and they send us mimeographed or xeroxed copies. It is the kind of use that determines the particular type of library you have. The whole flow of new information is becoming overwhelming in the broad sense, and it has to be computerized. I am sure you found out much more last night as to how it will develop. It is a very big problem.

Dr. Grace: I think most of the laboratories in Sheridan Park, at least several of them, came from somewhere else. In our case our library is the company's science and technological base for Canada. As a centralized service gets built up, we can use it to advantage. We want to work in that direction. At the same time we have to have operations in more countries and we have to have a fair amount of books out, you know, quite a bit of the time. We are the focus for our own company, and we also tie in as part of the Park. We also tie in with the universities around us as well. For instance, we have a tie-in with Erindale College which is part of the University of Toronto. They get a tie-in with the University of Toronto library. It is two miles away as the crow flies. So it is a sort of expanding area and none of us want the cost of maintaining a completely independent library, but there has not been any alternative. There may be, eventually.

Mr. Wellington: I want to point out that the companies in the Park are not there for the purpose of co-operating. That is not our business. Our business is to do research and development for our companies. That is the main thrust of our effort. As Dr. Grace says, we co-operate one with the other when it is convenient and when we cannot do the work effectively by ourselves. If it benefits economy and efficiency of member companies, then we co-operate to that extent.

Senator Robichaud: Mr. Chairman, in Dr. Grace's brief at page 11 he says, dealing with federal support of research and development, that the collective experience of the members of the Sheridan Park Association can point to several areas where improvements in federal aid programs can be effected. I presume that he is referring to such incentive programs as IRDIA, PAIT and NRC grants.

Then, Dr. Grace, you state the number of agencies or departments of Government administering tax incentives and financial assistance programs should be reduced to perhaps only one authority, that the present system is confusing to many industrialists and duplicates unnecessarily administrative functions. You suggest that it is wasteful of the efforts of those it seeks to help.

Could you add to that and tell us particularly what kind of authority you have in mind? Do you think of a minister of science or would you say that it should all be administered by the NRC? What do you really have in mind when you speak of one authority?

Dr. Grace: You have raised a very good point. Let me deal with certain problems for the record. One has been that, in the case of IRDIA that you mentioned, of the seven companies for profit in Sheridan Park, three have felt unable to take advantage of IRDIA, which is a specific example of something that bothers one. There have been cases, as I mentioned once before before this Senate committee, where a company quite prepared to come into Canada from the United States with a Canadian operation did not generate sufficient funds to fund it entirely in Canada at the particular time. They were told that, therefore, since they funded this laboratory from

outside the country they would not be eligible for IRDIA. This discouraged them from coming into Canada and into Sheridan Park.

These are two kinds of difficulties and they are both related.

I did not personally write this part of the brief, but I think we have known, in the case of PAIT, for instance, that a fair amount of administration is involved also. They have both been administered by the same department, probably.

My own experience has been with the National Research Council industrial research assistance program, and I have found that very straightforward. It has two great advantages, one being that you know in advance so that you can plan to use it and the other being that you are dealing with an administrator who has some discretionary powers to help you do the right thing in meeting the spirit of the situation, so to speak. I would therefore favour a move to consolidate the administration of incentives.

When I appeared for my own company about a week ago, I did outline four different cases, four sorts of situations that might apply to different kinds of incentives for development and for the subsequent innovation. I wonder if any of my associates have a specific feeling for the type of agency? Perhaps I am biased. I have had a long association of having worked with the National Research Council and I have had a long, very happy association with them. All other things being equal, I would say they might be the people for the job.

Senator Robichaud: You are not the only one to say that. Many witnesses have expressed the same views.

Senator Grosart: Would this one authority include the defence program incentives?

Dr. Grace: If practical. In other words, you set up an ideal and then you don't always achieve it for a very practical reason. I am not competent to answer that.

Senator Grosart: About half the programs are defence and much more than that is defence in terms of money.

Senator Bourget: In that case, Mr. Chairman, you are talking about a company making application for subsidies or grants. You are not talking about the association itself.

The Chairman: No.

Senator Bourget: It is the individual company which has to make the application.

The Chairman: Yes.

Senator Grosart: I believe it was said that three out of the seven profit companies had not been able to take advantage of the IRDIA incentives. Do I take from that that four of the seven were able to?

Dr. Grace: That is my impression. However, I notice that one of the companies appearing before your committee indicated that they had had their claims slashed because of doing work for their American subsidiaries. I don't think any of the companies are fully satisfied, but three of them have been excluded.

Senator Grosart: If they were fully satisfied, we would have the millenium.

The Chairman: When you apply for a grant under IRDIA, do you see the same people as when you apply for a subsidy or an advance under PAIT?

Mr. Holland: They are different staffs.

Dr. Grace: I think they are different staffs, yes.

Mr. Wellington: This I think is the problem. It is not only a responsibility, but it involves in a sense an interpretation or a definition of what is research, what is development and what is innovation. They do not have the same definition.

Senator Grosart: Because they are both set up to deal with the entire question of R and D funding requirements.

The Chairman: They might have the same definition even if they do not have the same purpose.

Senator Robichaud: Could we have the views of the other witnesses on the type of authority they would suggest to look after incentive programs or grants or do they agree that NRC could be or should be the main agency.

Mr. Holland: Do you mean, Senator Robichaud, that this one agency would also administer the programs as well as advise the government on research expenditures?

Senator Robichaud: I think so.

In your brief here you say:

(1) The number of agencies or departments of government administering tax

incentives and financial assistance programs should be reduced, perhaps to only one authority.

This is what your brief is suggesting and I am posing my question on this extract from the brief itself.

Mr. Holland: I think in answer to that that we would be the first ones ourselves to look at the matter in a somewhat different light from when the brief was originally written.

Mr. Wellington: I had something to do with the writing of the brief, so far as its historical aspects are concerned, and that was fairly easy. But when you get into the question of federal support for research and development you get a conflict between what ORF thinks and what others think. We do not have a view as to who it should be, but we are dealing with a difficult situation, I think. There are too many people to talk to. I do not know if we have any recommendations on this point to make to this committee.

Senator Grosart: But the writer of that said "perhaps".

Senator Robichaud: And then at the bottom of the page we see:

> The Sheridan Park Association agrees with the Economic Council of Canada that a program based on a percentage of expenditures would be more effective and more equitable.

My question is who would you suggest should determine the percentage. Would it be industry or government or the agency responsible for such programs?

Mr. Stadelman: Well, there is some trepidation about answering this.

The Chairman: I would hope the Government would have something to say.

Mr. Stadelman: The Government of Canada decides how its tax money should be spent. It also decides the regulations under which industry should work. I would hope, however, that they would give consideration to what interested parties have to say.

Senator Grosart: You are dealing now with tax incentives.

The Chairman: This paragraph deals with the question of a tax base and a tax period.

Senator Robichaud: This is the paragraph that suggests that more support for industrial research really should be given by the federal Government and that it should be based on percentages.

The Chairman: Straight percentages rather than additional expenses compared with a past period.

Senator Carter: I think there was some sort of consensus, at least I got the impression that there was, among the companies who appeared last week. They seemed to think that there should be two types of programs, one would be a tax incentive program for large companies, because tax incentives would not mean very much to the small company; but for a large company the tax incentive or some sort of tax rebate would seem to be almost ideal. But for a small company getting started there would seem to be need for some sort of grant or subsidy on the lines of NRC and PAIT although nobody was very enthusiastic about them. But there was or there seemed to be a consensus that there should be these two broad types of program.

The Chairman: I don't know if it would cut the red tape if we move from grants to tax abatements. I think you would still have the red tape. Again, is there less red tape in the Department of National Revenue than there is in the Department of Industry?

Senator Bourget: The main question is what kind of expenses would be allowed.

The Chairman: I understand this was also a criticism of the tax abatement method that the revenue people would not be able to give advice to companies as to what expenses or what kind of expenditures would be allowed until the tax returns were in. There was great uncertainty there, even greater than we found in the Department of Industry.

Senator Bourget: Marketing research is not accepted and many companies have said that marketing research is very important.

Senator Carter: If you have a policy designed beforehand the company would know.

Senator Grosart: But we have that now. The policy is very clearly defined. Of course everybody does not agree with it, but I have examined all the programs and the policy is clearly defined. Furthermore it is defined in many particular situations. I would like to say at this point that we have had a spate of criticism particularly of IRDIA and PAIT from a certain group of companies who may not be able to take the same advantage of it

as other companies. I would not like to have the impression left at this our last meeting that all the evidence we have had has expressed criticism of PAIT and IRDIA, because on the other hand we have a considerable quantity of evidence praising the effectiveness of PAIT and IRDIA. I am not taking any position one way or the other, for this is something to be looked into. But for the record I would like to make it clear once again that we have not heard from the Department of Industry, Trade and Commerce since we heard the criticism.

The Chairman: We had Dr. Warren, Deputy Minister of Trade and Commerce.

Senator Grosart: But not since we heard the criticism.

Senator Carter: How many disciplines are represented in Sheridan Park?

Dr. Grace: That is a very good searching question again. I would be interested in my associates' reaction to this. Sometimes we view chemistry as a discipline, but as we mentioned when we appeared before you CIC has 11 sub-divisions of one discipline and then there is something like chemical engineering and other areas where they do not have sub-divisions but they are considering forming them. Chemistry goes with physics and so right next door you have a division of chemical physics, but the people working in the field do not know which they are doing. I am not trying to evade the question, but it is a very broad area—chemistry, physics and engineering and of course there are some of the life sciences. Perhaps Mr. Stadelman might like to add something.

Mr. Stadelman: I find the same difficulty in knowing how we look at this term discipline. Warner Lambert is concerned with the clinical testing of drugs on animals and indeed the testing of drugs within the university hospitals. There is the ORF, industrial microbiology, physics and all phases of chemistry and highly specialized design consultants. For instance, we have worked with A. V. Roe in the design of turbines which is quite a distance from the design of a shaft for a pump. We have helped AECL on certain stress analyses which is purely mathematical. A mathematician can do this sort of thing—mathematics, physics, chemistry and the life sciences. I was going to exclude, say, medicine, but Dr. Lumb the President of this association is a medical doctor. Even there I was wrong.

Senator Carter: Do you think it might be worthwhile having social scientists on the staff?

Mr. Stadelman: Do you want my personal view? I think the social sciences have been neglected in Canada. It seems to me, as one who has spent most of my life in the field of physical sciences and research, that the present problems today are in the social sciences. We must get on in sorting and expanding them and, I hope, making them a little more practical in their objectives. I should like to see them concerned with some of the problems of the city rather than the way goldfish react to something or other.

Senator Carter: It seems to me in a community like Sheridan Park you have a marvellous opportunity to do some human studies, even population studies. For example, where do the researchers come from and what is their turnover? Have the benefits of working in other laboratories improved stability? There should be a lot of questions like that. Have you done any studies or anything about it? If you had a social scientist on your staff, you could probably think of others as well—I think you have got to think in terms of going beyond your products out into the population to see how these products impinge—

The Chairman: I understand, senator, that the association has no staff.

Dr. Grace: We have a part-time secretary treasurer. You have made some very good suggestions. We have been thinking a little bit in terms of bricks and mortar in the early days and now more recently in the direction of disciplines and objectives. We should like to see an electronics company in Sheridan Park and also a large chemical company. There are many chemical interests, but a large purely chemical company is not represented. We would like to see in Sheridan Park some grouping of the surrounding universities placing some of their "exotic" expensive equipment, that they need all the time.

We think in terms of perhaps some environmental institute, to study air pollution. We should like to see an innovation centre. We have been giving some thought on how to promote innovation. We agree that it is one of our key problems in Canada. How do you do it more effectively? Do you establish a facility in which it can be done? Perhaps the facility might be financed through some local or pro-

vincial government, because the results would be nationally funded from the federal Government. We are bringing some thinking into sharp focus.

I have not answered your question. We have had a little bit of a blind eye. Recently I have personally begun to appreciate the points you are raising. We have the universities around us, but our contacts with them, even though increasing, are still with the deans of science or the deans of engineering. Occasionally we have had one session with the presidents of the surrounding universities, but we have not had enough contact on the social level.

Senator Grosart: There is a statement on page 11:

> ...that the rate of increase in industrial research and development is now declining.

What is the magnitude of the decline, and in relation to what period? This is the total for Canada I take it.

The Chairman: The rate of increase.

Senator Grosart: The rate of increase is declining.

Mr. Stadelman: I think that statement is based on the recent DBS publication of industrial research and development expenditures in Canada. It came out this summer about six or eight weeks ago in which it showed the change in the rate of increase of industrial research and development for various years.

The Chairman: This is the rate of increase of federal funding of industrial research.

Senator Grosart: That is not what the statement says.

The Chairman: This is what was shown by the publication.

Mr. Stadelman: Did it not also show the rate of total expenditures of industrial research, which is also declining?

Senator Grosart: That is the statement here. I would be interested in any information. In my mind it is the most important statement in your brief. What this refers to is the period of decline and the period of a whole new set of federal incentive programs for industrial research. If this statement is true, someone has to examine the philosophy behind the federal Government incentive programs.

The Chairman: I think if we compare, for instance, the pre-Avro situation with the current situation it might be true. Certainly since the 1960s the rate of increase has continued to rise. I think the share of the federal funding has declined.

Senator Robichaud: Mr. Chairman, it is covered very well on the next page. They show a percentage.

Mr. Stadelman: The data which I have here, if misquoted, is from this DBS publication. We may have misinterpreted it.

The Chairman: I think you have the right interpretation, as Senator Robichaud says. You mentioned the current federal percentage as being 13 per cent.

Senator Grosart: The figure has declined from 18 per cent to 13 per cent.

Senator Bourget: Has it gone down compared with the industry's share of research?

The Chairman: Industrial research has gone up.

Senator Bourget: More rapidly than the federal share?

The Chairman: The federal share of funding of that total has gone down.

Senator Grosart: I raise the point, Mr. Chairman, that this is a comparison. That is why I asked the question about the period 1965 to 1968, which is the period of these particular incentive programs. Can anybody explain this?

Senator Carter: It is explained by the industries themselves.

Senator Grosart: No, this is a period when all the evidence before us—

The Chairman: I have been told by Senator Grosart, day after day, that perhaps these programs were helpful, but they were not too helpful. Perhaps this is the answer.

Senator Bourget: You were told, if you remember, that many companies said this basic period prevented us from taking advantage of some of those programs.

Senator Grosart: I should like to continue this questioning for a moment, if I may. This is a very important matter. One answer, of course, can obviously be that these are new programs which have not got into gear yet. We are in an area when the main evidence

before us in regard to the distribution of federal Government funding seems to be that our main deficient area is in the funding of industrial research. This statement and these figures are alarming.

I should like to ask these gentlemen if they can give us any rationale for this. Can they explain why this is happening? Is the fault on the side of government or is it on the side of industry? A corollary question is: what has happened to industry's own funding in that same period of research and development?

The Chairman: Have you tried to get as much money from the Government as you could?

Dr. Grace: Yes.

Mr. Stadelman: These are very difficult questions to answer. You must remember that that paragraph on page 11 refers to the rate of increase which is the second derivative, not the first one. And here it says that the rate is decreasing. We are dealing with an area where there is no doubt there is a relationship between science and the teaching of science, its application and industrial and economic progress. We see this all around us all the time. But I don't think we know quantitatively what this relationship is. Perhaps it is a little early yet. I think it has only been used as an effective tool for industrial advancement within the last two decades, particularly since World War II. It is not surprising, therefore, to me that we don't understand the quantitative relationships, because they are strung out.

Let us just look briefly at an example, the transistor. The technical knowledge of a semiconductor material was known in the 1900s, I believe. The mathematics to conceive the transistor was known about 1930. Nobody thought of making a transistor until 1945. The Bell Telephone lab set out to do it and they did it and did it so quickly that, to some extent, the success was serendipitous. But today when you walk down Yonge Street in Toronto the transistor radios you hear coming at you from all of the stores have been made in Japan. There is a funny story there somewhere. What it all adds up to I don't know.

Senator Grosart: Perhaps I can make my question more specific. These figures deal entirely with a percentage. I take it that it is a percentage of the total funding, although it is not so stated here. It is a percentage of total funding of research and development in industry, and the statement is that the federal Government's percentage of the total has declined. Does this mean that the industries' total has increased?

Mr. Stadelman: It must from a mathematical standpoint.

Senator Grosart: Not necessarily.

The Chairman: The total expenditures have increased.

Senator Grosart: It can either mean that the total expenditures have increased or that the federal funding has diminished to such an extent that it is lower as a total percentage.

Mr. Stadelman: I would have to refer to the DBS data in order to answer your question specifically.

The Chairman: I remember seeing that table, senator, and I think that the total amount of federal money devoted to industrial research has increased. But the total amount of industrial research has increased at a faster rate so that the federal relative share has declined.

Senator Grosart: That would be contrary to some of the evidence we have had.

The Chairman: This is DBS evidence.

Senator Grosart: I am satisfied.

Dr. Grace: One senator raised the question of what happened to Sheridan Park—it had such a quick growth but there have been no more participants in the last several years. I am a director of Sheridan Park Corporation, along with Mr. Holland here, and we have been trying to interest other companies to come in, but they have declined. The climate has been such that they have been moving to build some laboratories outside Sheridan Park, but there has not been a large increase in the numbers of laboratories. Certainly, none have come into Sheridan Park in the last couple of years or so. We have been working on it and so has the association been working on it. We have been trying to spread the gospel, as we like to say.

Senator Bourget: You are trying to get companies outside Ontario?

Dr. Grace: We will accept competitors, even. We had all our major competitors to visit us.

The Chairman: If you were to make a study of the advantages of being together, which

apparently you have not done yet, perhaps you would be in a better position to convince other people to join.

Mr. Holland: I think that is so.

The Chairman: Until you have done so, I think there is reluctance on the part of individual companies to join with others while, as you say, their primary objective is to work for the company. If there is no spin-off or indirect advantage to being together or no evident advantage, but on the other hand perhaps fears, then I don't see why they should join.

Mr. Holland: Part of the answer to this problem is that the companies there now are the pioneers and it is just a little too soon yet to come up with a case history or a study.

The Chairman: The others are perhaps more conservative.

Mr. Holland: Next year, after a five-year period of the companies working together has elapsed, there might be a better picture. Further to what Dr. Grace said, there have not been that many laboratories set up in Canada in the last four years. In other words, if there had been a lot of laboratories of the type found in Sheridan Park established in other places than Ontario and who had chosen not to go into the park, I think we would be very concerned, but this has not happened. There has been expansion of laboratories at the manufacturing sites, but there have not been that many new laboratories established away from the manufacturing sites.

Senator Grosart: Mr. Stadelman, I should like to ask you a question in your capacity as President of the Ontario Research Foundation. I take it that you are not satisfied with the funding for the foundation that you are getting from the federal Government?

Mr. Stadelman: I should like to see it increased, yes.

Senator Grosart: There has been a suggestion that there be other research institutes located in the university milieu. Do you think these would conflict with the efficiency of the total research effort by, say, professional research institutes?

Mr. Stadelman: I think anything that will contribute to industrial development of our country is good, and to the extent that these university industrial institutes can contribute, I am all for them.

I do think, though, that they present a problem to the universities, but this is for the universities to decide. It has nothing to do with me. The Carnegie Institute for the Advancement of Teaching has a report on the University Services Society which discusses certain aspects of this problem. However, that is a university problem.

Vis-à-vis ORF, there are only two areas giving me concern. One is that these institutes charge full overhead, such as we must charge to remain viable. Also, I think, they should charge full overhead so they will not draw on educational moneys to give it out to industry.

Secondly, our staff are not allowed to consult privately. They are employees of ORF and their total consulting income goes into ORF.

To an extent I should like to see the same practice within the university industrial institutes; the money given to a university professor for consulting for the institute should not be in addition to his salary. These are the two areas of competition that give me as President of ORF concern. I am all for them if they contribute to industrial development.

Senator Grosart: The purpose of my question is this: is it fair to say that the political decision-maker in an attempt to satisfy everybody may diffuse the effectiveness of funding by setting up too many institutes, that it might possibly be a more efficient way to set up very large centres of institutional research rather than to have a great many not quite so excellent?

Mr. Stadelman: I think there is merit in your suggestion that institutions that are devoted to contract research only, such as ORF, can offer a better service if they are widely based because you bring into play on other problems the myriad skills necessary for taking an idea from the concept stage to the market. Looking at the industrial research institute, what it does is to take the advantage and the experience of a man teaching in university and gets him into industry for this purpose. I do not think it is an institute to do simply research but to transfer this highly-skilled knowledge to industry. So I do not think there is a conflict from a funding point of view.

Senator Grosart: Except that it brings you back to the area of the percentage of funding that should go to basic and applied research. We had a brief yesterday which said it should be part of a national science policy to keep

the percentage of funding for basic science below 10 per cent. Would anybody care to comment on that?

Since there is no comment, let me put it in another way. Should national science policy be concerned with the percentage of federal funding going into the performance sector as between basic, applied, development and innovation.

Mr. Stadelman: I think it should. We as a nation should contribute to world knowledge in accordance with our wealth. We have a duty and an obligation to expand world knowledge as any country has to do. However, if the taxpayers' money is to be used for the purpose of increasing industrial productivity or to arrive at the solution to some of the technological social problems of our day such as pollution, I do not think the most effective way to spend that money is in the field of basic science, because it is almost fortuitous if there is an occurrence within that field that is going to reflect something in industry or a social technological area. I think the two things are quite different. We put the money in basic science to maintain and support our world knowledge as we have an obligation to do.

Senator Grosart: The figure we were given for that is three per cent.

Mr. Stadelman: Three per cent or five per cent—I have never made a study of it.

Senator Grosart: But if our likely contribution to world knowledge is three per cent, does it mean that we should under a national science policy put more than three per cent into basic?

Mr. Stadelman: I do not think so. I would put that money into problems that are political in nature. You have to decide what Canada's problems are and then devote your money to them. You would say to the scientists "pollution is a problem of industrial development", or "this is a backward area—can you do something about it?" Then we should use all our facilities and knowledge to give you a program that we consider might provide a solution. But I think the overall decision is political rather than scientific.

Senator Grosart: I do not entirely agree with that. It is both. If it is political rather than scientific, we are in a mess with a national science policy. Am I correct that your suggestion is that the total percentage of total federal funding of basic science would be whatever is necessary to maintain the necessary capability to absorb and assess technological problems?

A final question, Mr. Chairman. We have two companies here who are subsidiaries of foreign companies, and a suggestion has been made in a brief that a national science policy should make it compulsory for all subsidiaries of foreign companies in Canada to spend a percentage of sales on R & D in Canada relative to those of the parent company in relation to its global sales. Do you think a national science policy should get into that area?

Dr. Grace: I would like to group these two together for a moment. First of all the feeling has been expressed that we are out of balance in our support of basic as compared with our support of the innovative process and the application of knowledge. I think in any move we make we must work gradually because we have a very enviable set of educational institutions with our graduate, post-graduate and doctoral students, and I do not think it would be in the national interest to destroy them. So I think if we can afford it we should be bringing the increase into the applied areas and the innovative areas so that eventually the percentage of basic will be right, whatever "right" is. I do not think we should bring the axe down and try to do it this year.

I would much prefer to deal with the question of international companies and their subsidiaries and associated operations. I would much prefer to try to approach this by improving the climate for doing research, development and innovation to make it so that they would really want to do it, to make it so it would be really worthwhile and to make it so that there would be a pay-off. Then you will have a happy situation. Now to reverse this may not be easy. I can quote an important example from our own industry. A few years ago there was a new laboratory established on the Polymer process at McGill and there was a proposal made that the manufacturing association related to Polymer should give some money towards this. I made the proposal myself and was turned down flat. Within a year the man who turned me down made a reverse and said that to be good citizens of Canada they should support the Polymer science.

Senator Grosart: May I say this to help you with your answer? The suggestion that it should be compulsory assumes that there would not be a market incentive. If there

were such market incentives, it would not be necessary to make it compulsory. I would assume your suggestion is that even if it does not pay off, there should be a requirement by law.

Dr. Grace: I am not prepared to accept that recommendation at this time.

Senator Grosart: I am not advocating it either.

Senator Bourget: Sheridan Park Corporation is a crown corporation and I wonder if we could get a copy of the bill that set up the corporation.

Mr. Holland: Yes.

Senator Bourget: And my last question is; how much of the cost is paid by the province, that is the total cost of your organization? Have you got those figures?

Mr. Holland: Yes.

The Chairman: My last question will be addressed to Dr. Grace. You remember that when he was here as President of the Canadian Chemical Institute he was accompanied that evening also by the Association of Physicists. We started to discuss ways and means of getting at least the economic and professional and scientific community in Canada closer together. I understand that since this suggestion some progress has been made in an endeavour to call a meeting in Ottawa towards the end of July, and I should like to hear a progress report from Dr. Grace on his activities since our last meeting with him.

Senator Grosart: That is provided it is not confidential information which Dr. Grace would not want on the record.

Dr. Grace: No, it is not confidential.

Senator Grosart: Sometimes it is better to work in the dark on these things.

Dr. Grace: The challenge that was put forward by your committee took the physicists and the chemists a little bit by surprise. Perhaps we have always felt it was somebody else's responsibility to speak for science. I was a little surprised, and felt like saying: "Who, me?"

In response to this challenge we decided to hold, as Senator Lamontagne has said, a meeting of the national scientific, engineering, health, and technical organizations, and the organization is well on the way. It will be co-sponsored by the Canadian Association of Physicists, the Chemical Institute of Canada, and the Engineering Institute of Canada. It is to be held in Ottawa at Carleton University on July 31 and the morning of August 1. We are expecting to have an assurance from your chairman that he and, I hope, members of his committee will attend this meeting of the presidents along with the staff officers of these 60-odd organizations which have been invited, to issue this challenge and to tell us a little bit more about what the scientists, engineers, and the people in the health sciences and in technology, can and should do to help our decision-makers reach decisions that are in the best national interest.

In addition, during this first meeting on the morning of July 31 we have asked the leaders of a number of science activities—the Science Secretariat, the Science Council, the National Research Council, and the Medical Research Council—to also come and speak very briefly on this question, and relate to the conference what their problems are, and how we might help by way of interconnection with them on a continuing basis.

So, I am quite optimistic that we are going to have a successful meeting. If you hit that meeting as hard as you hit us on the other evening when we met, then we will have a continuing organization—a national congress, a national forum, or conference—of some kind.

We are most grateful to you, and we look forward to your helping us on July 31.

Senator Grosart: I am very glad to hear this, because personally it means that the suffering I endured the day after that meeting in the Chateau Laurier was worthwhile.

The Chairman: You have decided not to invite a national association concerned with the social sciences? Can you give us the reason?

Dr. Grace: This will be the first time that we have had, I think, all four different areas that we touched upon. We feel that they are pretty dissimilar in their points of view. We know that the economic and social implications of science are vital, but once we have some kind of meeting of minds we hope we do not have as a next step just another Tower of Babel. The reasons are not very good, but it is a matter of making haste a little more slowly perhaps than some of us would have wished to do.

The Chairman: I think it is probably a very good practical reason. On that very happy

note for the future I think we should adjourn. I hope we will be equally successful in convincing the industrial community to do the same, and try to find some kind of base upon which they will see fit, some day in the near future, to organize what I would call perhaps a national conference on industrial research.

Senator Grosart: We might even get government departments to get together.

The Chairman: We hope to try to see to that at least through our report.

These are the last public words of this committee. It has been a great experience for us, and I hope it has also been a happy experience for those who, like you, have accepted our invitation to appear before us. We want to thank not only you but all those who have appeared before us for their most active collaboration. They have been very useful to us in this very difficult task.

Mr. Holland: If I might speak for this group and those that are not here, I would like to thank the Special Committee of the Senate on Science Policy for at least helping clarify in our own minds which way we should be going. If nothing more should come out of this, it has been a major contribution to the national research programs for Canada. We are all very grateful.

The Chairman: Thank you very much.

Dr. Grace: To that I would say amen. I think this is the greatest thing that has happened in Canada since—well, since Confederation.

Senator Bourget: Vive le Canada!

Senator Grosart: I do not want to be influenced by the somewhat exaggerated statement of Dr. Grace, but I think it would be inappropriate if we wound up our public hearings without somebody on behalf of the members of the committee saying to you, Mr. Chairman, that we are all aware, as I believe the whole scientific community is aware, of the tremendous leadership you have given, first of all in proposing this committee, then persuading the Senate to set it up, and finally presiding over the administrative arrangements and the meetings themselves in a way that has brought credit to the Senate. It will be of lasting benefit to research and development in Canada. To you, Mr. Chairman, for the part you have played, more than to any other person or representative group of persons, the large part of the credit must go.

Senator Bourget: I am happy to second those remarks on behalf of the members of the committee.

Hon. Senators: Hear, Hear.

The Chairman: I think you very much, but I must associate with that the members of the committee, who have devoted so much time to this work. Thanks should also go to our staff, who have been so helpful not only to me but to al members of the committee.

Hon. Senators: Hear, hear.

The committee adjourned.

APPENDIX 187

THE SHERIDAN PARK ASSOCIATION

BRIEF

TO THE

SENATE OF CANADA

SPECIAL COMMITTEE

ON

SCIENCE POLICY

May 31, 1969

INTRODUCTION

Sheridan Park Research Community

What it is

How it started

How it works

Sheridan Park Association

Objectives

Major Policy

Some Achievements - 1) Visitors
2) Conference Centre
3) Special Conferences and Meetings
4) Technical Coordinating Committee
5) Associate Membership

Federal Support of Research & Development

SUMMARY

The main purpose of this brief is to acquaint the Honourable members of the Senate Special Committee on Science Policy with the Sheridan Park Research Community - how it was formed, how it operates and what it does.

Sheridan Park Research Community is a park-like area, 17 miles west of Toronto, where nine Canadian organizations carry out applied research and development in science and technology.

After the results of a survey showed that Canadian industry supported the research community concept and following an exhaustive search for a suitable location, Sheridan Park became a reality when Dunlop Research Centre, International Nickel Company of Canada Limited and Cominco Limited agreed to join with the Ontario Research Foundation in constructing new research and development laboratories on a common site.

To-day there are nine organizations with laboratories in Sheridan Park, each conducting their own independent programs but enjoying the advantages of an attractive research environment, the opportunity of transferring non-proprietary information and advice, the access to a diversity of skills and facilities and the sharing of certain facilities and programs for professional and social purposes.

Sheridan Park Association is comprised of companies owning property or operating research facilities in Sheridan Park. The Association has played an important role in the success of Sheridan Park. Its broad objectives are to assist the community in being an outward-looking science centre dedicated to efficient and creative industrial research and development and to provide appropriate community facilities and programs for its member companies.

Summary Contunued

Sheridan Park and its Association have made notable achievements. Sheridan Park is now internationally recognized and regularly receives many visitors. A new Conference Centre has been the scene of many conferences, seminars, lectures, meetings and educational courses. One of the Association's eight committees, the Technical Coordinating Committee, has been actively engaged in programs and activities related to the broad field of scientific and technical information - indexing, storage, retrieval and dissemination. The Association is considering ways to extend its facilities so as to assist a larger segment of interested industrial companies in Ontario.

All of the members of Sheridan Park have had experience with the many federal tax incentives and research assistance programs. While present measures are helpful and commendable, improvements are required and can be effected in several areas:

(1) The general tax incentives should produce support for current research expenditures, as well as increases in such expenditures and should also eliminate restrictions such as funding in Canada.

(2) Restrictions in some programs about sub-contracting research and in conducting market research should be eliminated.

(3) A larger portion of industrial research and development should be supported by federal funds.

At the invitation of the Honourable Chairman of the Senate Special Committee on Science Policy, this brief is submitted to acquaint the Honourable Members with Sheridan Park Research Community and the association comprised of its member companies, Sheridan Park Association. The brief will present the story of Sheridan Park - how it started, how it works and the roles it is playing and hopes to play in Canadian science and technology.

Most of the Members of Sheridan Park have submitted their own views on Science Policy in Canada. This brief will not attempt, therefore, to make a coordinated summary of such individual and possibly, varying opinions. There is general agreement, however, in one area that has a most important bearing on applied research and development and a few short comments and suggestions will be made about the inadequacies of present industrial research incentives and research assistance programs.

SHERIDAN PARK RESEARCH COMMUNITY

What It Is - Sheridan Park is unique. It is Canada's first, and so far only,integrated community devoted to applied research and development. It occupies 348 acres of parkland on the north side of the Queen Elizabeth Way, 17 miles west of downtwon Toronto.

In an environment carefully planned for the purpose, nine organizations conduct their independent programs of industrial research and product development. The concept of Sheridan Park was and is the creation of a "research atmosphere" conducive to the efficient pursuit of research objectives.

Just over 1600 scientists, engineers, technicians and ancillary personnel are employed in Sheridan Park and over $34 million has been spent on building construction. Details of the research facilities of member companies are listed in Appendix I.

How it Started - Late in 1960, the Ontario Research Foundation (O.R.F.), the largest, independent, non-profit organization in Canada that conducts research and development for industry and government on a confidential contract basis, decided to vacate its outgrown facilities at Queen's Park in central Toronto and move to a new site. Two choices were open: to find a site suitable for O.R.F's needs only or, following a suggestion which had been put forward a few years earlier, to choose a location where others could build research laboratories close to O.R.F. and form a research community.

The results of a careful survey showed enthusiastic support by industry for the research community concept. Along with Dunlop Canada Limited, International Nickel Company of Canada Limited and Cominco Limited, O.R.F. began to look for a suitable area. The choice of Sheridan Park from among about 35 possible sites was based on convenience of access to universities, libraries, industry, good residential areas, services, transportation and other relevant factors.

Sheridan Park is within 20 miles and a 30 minute drive from Toronto International Airport. Four nearby provincial highways give easy access to major cities in Southern Ontario, to Montreal and to the United States. Nine universities are within easy driving distance: Toronto, York, McMaster, Guelph, Waterloo, Brock, Western Ontario and Trent. Erindale College, a suburban affiliate of the University of Toronto is only three miles away.

Standard sites in Sheridan Park range from three to ten acres. All are fully serviced below ground with water, gas, electricity, storm and sewage facilities and communications services. Landscaping features include an illuminated stone entrance, special street lighting and illuminated pools and fountains. Sheridan Square, a building providing a conference room and limited commercial services, was built in 1968. A site has been set aside for another, larger building to house additional commercial, technical and office facilities.

The original site consisted of 293 acres of which O.R.F. purchased about 100 acres on the condition that the remaining land would be reserved exclusively, at controlled cost, for industrial research laboratories. A plan for the general layout of the community was drawn up and the three companies which had collaborated with O.R.F. to establish the park bought land for their individual laboratories.

Gulf Oil Canada Limited, formerly the British American Oil Company Limited, had bought land adjoining Sheridan Park before it was selected for the research community and since inception of the Association has been a member of the community. Similarly, Mallory Battery Company of Canada Limited, had previously established a light manufacturing plant next to the site. When it added a research facility, Mallory also joined the community. These two industries have added to the original land area and have increased the total to the present 348 acres. Three other companies have bought land and constructed laboratories in Sheridan Park - Abitibi Paper Company, Atomic Energy of Canada Limited and Warner-Lambert of Canada Limited. Only about 104 acres of the site remains for future participants.

In 1964, the Ontario government, anxious to preserve the long-term development of the research community, formed a crown corporation, The Sheridan Park Corporation, which bought the remaining lands from the original land development company and undertook to administer its sale on a non-profit basis. Companies that locate in Sheridan Park must adhere to a few basic "ground rules" which have been designed to plan and maintain an environment attractive to scientists and to set standards for the community as a whole.

How It Works - In essence, the Sheridan Park Research Community provides the opportunity for a company to improve greatly the efficiency of one of its important operations - its research and development activities. In this age of rapid scientific and technological progress, a scientist cannot work effectively in isolation; he requires access to modern, expensive equipment and libraries; he requires a means to remain constantly in touch with new developments in his field. Furthermore, because most research programs involve many scientific disciplines, contact with scientists specializing in other disciplines is a decided advantage particularly when good research scientists and engineers are in short supply. If they can be provided with the necessary facilities and environment, not only will they be easier to find but also they will be more productive. This is the basic philosophy behind the research community.

Each company participating in Sheridan Park operates its own research laboratories independently of other members of the community and safeguards the proprietary nature of its research programs, as is necessary in a free enterprise economy. Cooperation is the transfer of non-proprietary information and advice is encouraged and is an advantage. Good examples can be cited in the cases where Mallory Battery scientists obtained useful information about zinc and interesting ideas for further development from Cominco and where Gulf Research supplied Dunlop with a special grade of sulfur.

The O.R.F. has often been referred to as the "nucleus" of Sheridan Park. This is accurate in some respects but misleading in others. While it is true that O.R.F. conceived the original idea and led the way in bringing the community into existence, O.R.F. also operates quite independently of other Sheridan Park companies. Since O.R.F. is essentially a centre for applied research, it will conduct research on a confidential, contract basis for any member of Sheridan Park in the same way that it will undertake work for any other client.

SHERIDAN PARK ASSOCIATION

The success which the community enjoys today is largely the result of the cooperative spirit of the members through the Sheridan Park Association. The Association, whose membership is voluntary, is comprised of the companies owning property or operating research facilities in the Sheridan Park Research Community. Every new firm to locate in Sheridan Park is eligible for membership - each has an equal voice in the Community's affairs.

Objectives - The Sheridan Park Association was an integral part of the research community concept. It was formed shortly after Sheridan Park was established with two general objectives:

(a) to assist the community in achieving and fulfilling its purpose of being an outward and forward looking science centre dedicated to the efficient prosecution of creative industrial research and development and:

(b) to establish, maintain and operate appropriate community facilities in the interests of member companies.

In particular, the Association seeks to promote the interests of its members, to maintain standards of physical development in the community, to provide scientific and technical liaison among its members and to establish a general policy that will underline the word "community" in the personnel and corporate relationships of its members.

Major Policy - To achieve its objectives, Sheridan Park Association's major policy is:

(a) To organize, operate and equip to meet, as far as practical, the collective needs and desires of the participants with particular reference to tools and aids for industrial research, central core facilities of a scientific or a commercial nature, and scientific and technical seminars, meetings and other related activities.

(b) To provide the means whereby each individual member can obtain the maximum advantage from its participation in the Association and in the community.

(c) To develop and maintain mutually beneficial relationships and activities with government, industry, the universities and other organizations outside of Sheridan Park.

Some Achievements

Sheridan Park is more than a collection of fine industrial research laboratories. Through Sheridan Park Assocaiation and the dedication of many community employees who have served on its committees, Sheridan Park has become an internationally recognized centre for science and technology. It has become a dynamic entity exerting a positive influence on Canadian applied research. The interchange of ideas, the matching of corporate and individual needs, the sharing of problems and cooperation both professionally and socially at all levels were dreams when Sheridan Park was conceived - today they are realities, playing important roles in the community's activities.

1. Visitors

Sheridan Park is visited frequently by people from national and international scientific and industrial organizations who come to learn, sometimes to teach and almost always to share in the advancement and application of science and technology. Representatives of many foreign governments have visited Sheridan Park to see how the research community works and if the concept can be applied in their own country. The laboratories and their general operation have become models for study by a wide spectrum of industrial management. There are growing relationships with educational institutions to the benefits of all concerned.

2. Conference Centre

Internal and externally oriented community activities have been enhanced with the opening, in the fall of 1968, of the Sheridan Park Conference Centre, the first stage of the ancillary commercial complex. The capital cost of equipping and furnishing this two-level auditorium and conference centre was provided by the Ontario Government through the Sheridan Park Corporation. Sheridan Park Association is responsible for its management and operation.

The premises of the Conference Centre will seat up to 200 in the main auditorium and there are overflow facilities and a cafeteria installation on a lower level. The Centre is available for use or rental for a wide variety of purposes, ranging from scientific seminars to science film festivals, from university extension courses to social activities. Use is growing constantly and the booking schedule for April 1969, attached as Appendix II shows an interesting assortment of events.

3. Special Conferences and Meetings During the Past 12 Months

(a) Sheridan Park Industrial R & D Management Conference

In keeping with the "outward-looking" aspect of Association activities, the Sheridan Park Association sponsored a regional conference on government incentives for industrial R & D. This highly successful conference was attended by government officials and by industrial research managers from as far away as Sarnia, Niagara Falls and Montreal. It resulted in further meetings in Ottawa and in Montreal.

(b) Third Canadian Fuel Cell Seminar

This seminar on Fuel Cell Technology was held in the Conference Centre.

(c) Meeting of the Science Council

The Science Council of Canada held their May meeting in the Sheridan Park Research Community at O.R.F.

(d) O.E.C.D. Meeting

The O.E.C.D. held all meetings concerning their activities in all of Southern Ontario in the Sheridan Park Research Community. The O.E.C.D. were conducting a special audit of Canadian R. & D. activities.

(e) Technical Society Meetings

Meetings of the Electro Chemical Society and the Proprietary Association were held in the Conference Centre. Meetings of the Managing Board of the Canadian Research Management Association were held in the Park. McMaster University also held an Inorganic Chemistry meeting at the Centre.

(f) Lamontagne Lecture

The first of the Sheridan Park Association General Lectures was held on January 27, 1969. Senator M. Lamontagne, Chairman of the Senate Committee on Science Policy, addressed an invited group of 75 industrial representatives from outside the community and about 100 representatives from inside the community on Canada's Science Policy. The lecture was particularly successful. It is planned to establish the "Sheridan Park Lectures" - a series of talks by internationally recognized authorities. This lecture was the first of this series.

4. Technical Coordinating Committee

An important committee of the Sheridan Park Association is the Technical Coordinating Committee. In the past two years it has made excellent progress in a number of areas, some of specific interest to the Sheridan Park and some, in keeping with the community's outward-looking policy, of general widespread interest.

This committee has compiled two indices of considerable working value to Sheridan Park, demonstrating the cooperative attitude of the members. One is an Index of Skills and Facilities available from all the member companies; the other, compiled with a computer and the help of the National Science Library, is a library list of serials or, a list of all the library holdings, in Sheridan Park. These lists are being kept up to date.

The Technical Coordinating Committee has arranged formal and informal seminars, including programs in combination with university staff. For example, Professor D. R. Wiles of Carleton University spoke about "Atomic Recoil Reactions and their Possible Uses".

At the Conference Centre, the Committee arranged educational courses in computer programming and effective reading. These popular courses were presented to the staff of member companies by the Extension Department of the University of Toronto. Another successful program was a series of 17 showings of films on scientific subjects.

In October, 1969 a two-day symposium at Sheridan Park on Materials Science, "New Concepts in Material", with lectures of international repute will no doubt attract a large audience not only from the community itself but also from industry which the community serves.

Another activity is concerned with library facilities and their use. This subject has been studied at length by the Science Secretariat and their recent report confirms the very great importance of the availability of information on science and technology to scientists and engineers concerned with research and development. All companies in Sheridan Park have shared in an experimental program of the National Science Library on the selective disemination of information. Eight are continuing the service on a fee basis.

Speedy access to good library resources is essential to effective operations at Sheridan Park. There has always been a modest use of the O.R.F. library by local industries. Library facilities and services will no doubt expand and, as they do, they will become an important resource also from the nearby industrial community.

A national information network has been recommended by the Science Secretariat and is a technical possibility now. Sheridan Park can be an important link in that network because it already has a good library resource and a technical information service that has helped industries in Ontario for many years.

5. Associate Memberships

The purpose of the Sheridan Park Association includes the "outward-looking" purpose of providing a centre for industrial research and technology serving the industrial community in Southern Ontario, particularly that portion situated around the western end of Lake Ontario. With this in mind, 130 companies and organizations were written to with the idea of establishing a channel of communication between the Sheridan Park Association and these external organizations. About 75% specifically requested that they be kept informed of events in the Park. The Association now has a special mailing list for this purpose, which includes 150 representatives of 100 industrial firms and 12 universities and educational institutions.

In keeping with this first step, the By-laws have been amended to provide for associate membership on some nominal fee basis. The Association intends to act upon this provision in the near future in order to accommodate a widespread industrial interest in Associate Memberships and to provide a further means of serving industries in Southern Ontario.

FEDERAL SUPPORT OF RESEARCH & DEVELOPMENT

All of the member organizations of Sheridan Park have, through experience, a close working knowledge of the many federal tax incentives and assistance programs for industrial research in Canada. Indeed, some of the members of Sheridan Park were able to take advantage of income tax incentives when Sheridan Park was being formed.

While the basic aim of federal incentives and assistance programs is commendable - to increase industrial research and development in Canada - recent figures show, in fact, that the rate of increase in industrial research and development is now declining. Incentives and financial assistance are not the only considerations that influence the growth of research and development, however, it is obvious that federal assistance programs are not exerting the desired influence.

The collective experience of the members of the Sheridan Park Association can point to several areas where improvements in federal aid programs can be effected:

(1) The number of agencies or departments of government administering tax incentives and financial assistance programs should be reduced, perhaps to only one authority. The present system is confusing to many industrialists; it duplicates, unnecessarily, certain administrative functions; it is wasteful of the efforts of those it seeks to help.

(2) Present tax incentives for industry are based on increases in expenditures over a moving average. This seems to place too much emphasis on supporting new industrial research. New industrial research undertakings are very expensive and will not likely occur in Canada with great frequency, even with tax incentives. The federal program would probably produce more effective results if it provided more support for existing industrial research resources. The Sheridan Park Association agrees with the Economic Council of Canada that a

program based on a percentage of expenditures would be more effective and more equitable.

(3) The restrictions in some programs about sub-contracting research to outside organizations and the exclusion from all programs of support for market research should be removed. Sub-contracting all or a portion of a research program to a competent Canadian organization often is the only way in which a company with limited or no research facilities can get started or can carry out a research program. Even many good industrial research laboratories could make effective use of many excellent outside resources.

Economics and science and technology are inseparable today. Market research has been ruled out of all research assistance programs but good market research can be a significant part of the cost of a research program. Because of its cost and because it is an integral important part of applied research and development, market research deserves financial recognition.

(4) In 1965 the Federal Government provided about 18% of the funds spent by industry on research and development. This compares to 55% from the Federal Government in the United States and 37% from the Government in Great Britain. Since then the Federal Government support of industrial research has been declining - figures for 1968 indicate the percentage now is in the neighbourhood of 13%. This trend must be revised.

Clearly, government support of industrial research must be greatly expanded if the overall level of research performed by industry is to meet the goal suggested by government itself.

George D. Lumb, M.D. M.R.C.P.
President

E. G. Fleming,
Secretary-Treasurer

APPENDIX I

MEMBERS OF SHERIDAN PARK RESEARCH COMMUNITY AND SHERIDAN PARK ASSOCIATION

ABITIBI PAPER COMPANY LIMITED

Building: Total Floor Area, 66,000 sq. ft.
Cost: $2.55 million
Land: 8 1/2 acres
Staff: 95 total

Research into pulping and paper making projects and panel board product studies.

ATOMIC ENERGY OF CANADA LIMITED

Building: Total Floor Area, 110,000 sq. ft.
Cost: $6 million
Land: 17 acres
Staff: 900 total

Development and testing of components for nuclear power stations and nuclear plant design.

COMINCO LIMITED

Building: Total Floor Area, 28,000 sq. ft.
Cost: $2.25 million
Land: 10 acres
Staff: 47 total

Research into the more efficient use of metals, particularly lead and zinc; and the development of new lead and zinc products.

DUNLOP RESEARCH CENTRE

Building: Total Floor Area, 19,000 sq. ft.
Cost: $1 million
Land: 4 acres
Staff: 40 total

Chemical research, polymers and new material exploration and development of new chemicals.

GULF OIL CANADA LIMITED

Building: Total Floor Area, 75,000 sq. ft.
Cost: $5.5 million
Land: 40 acres
Staff: 150 total

Research and development into new and improved petroleum chemical products and processes.

APPENDIX I - Continued

INTERNATIONAL NICKEL COMPANY OF CANADA LIMITED

Building: Total Floor Area, 73,000 sq. ft.
Cost: $4 million
Land: 10 acres
Staff: 62 total

Research in extractive metallurgy, product research, geological and geophysical research.

MALLORY BATTERY COMPANY OF CANADA LIMITED

Building: Total Floor Area, 2,000 sq. ft.
Cost: $60,000
Land: 10 acres
Staff: 10 total

Research into effective cell operation at low temperatures for space and military application.

ONTARIO RESEARCH FOUNDATION

Building: Total Floor Area, 202,500 sq. ft.
Cost: $9.472 million
Land: 90 acres
Staff: 250 total

Contract research for industry and government, scientific and technological investigations.

WARNER-LAMBERT RESEARCH INSTITUTE OF CANADA LIMITED

Building: Total Floor Area, 38,500 sq. ft.
Cost: $1.8 million
Land: 13 1/4 acres
Staff: 48 total

Medical Research, drug toxicity studies, drug efficacy studies.

UNITED LANDS CORPORATION LIMITED

The original land developer. Owner of the new commercial complex within the park and responsible for additional ancillary commercial use development.

SHERIDAN PARK CORPORATION

The Provincial Crown Corporation, with responsibility for future development of Sheridan Park, conducts all new land sales.

APPENDIX II

SHERIDAN PARK ASSOCIATION

SPA

EVENTS IN

SHERIDAN PARK RESEARCH COMMUNITY

SHERIDAN PARK CONFERENCE CENTRE

APRIL	1	S.P.A. - Science Film Festival	4:30 p.m.
	2	S.P.A. - U of T Extension Course Introduction to Computers	4:30 p.m. till 6:30 p.m.
	3	S.P.A. - U of T Extension Course Introduction to Computers	4:30 p.m. till 6:30 p.m.
	3	O.R.F. - Employees	9:00 p.m.
	8	A.E.C.L. - Employee Meeting	1:00 p.m. till 4:00 p.m.
	8	S.P.A. - Science Film Festival	4:30 p.m.
	9	S.P.A. - U of T Extension Course Introduction to Computers	4:30 p.m. till 6:30 p.m.
	10	S.P.A. - U of T Extension Course Introduction to Computers	4:30 p.m. till 6:30 p.m.
	15	S.P.A. - Seminar, Professor S. Sandler University of Toronto, "Advances in Opticometric Methods of Chemical Analysis"	4:00 p.m. till 7:00 p.m.
	16	S.P.A. - U of T Extension Course Introduction to Computers	4:30 p.m. till 6:30 p.m.
	17	S.P.A. - U of T Extension Course Introduction to Computers	4:30 p.m. till 6:30 p.m.
	17	Gulf Canada - Employees	9:00 p.m.
	22	S.P.A. - Science Film Festival	4:30 p.m.
	23	S.P.A. - U of T Extension Course Introduction to Computers	4:30 p.m. till 6:30 p.m.
	24	S.P.A. - U of T Extension Course Introduction to Computers	4:30 p.m. till 6:30 p.m.
	25 & 28	Foxboro Company - Display of Equipment	Two Full Days
	29	S.P.A. - Science Film Festival	4:30 p.m.
	30	S.P.A. - U of T Extension Course Introduction to Computers	4:30 p.m. till 6:30 p.m.

Sheridan Park, Ont. – Tel. 822-4111

ERRATA

Proceedings of the Special Committee
on Science Policy, No. 58,
for June 10, 1969

Title page	Under heading "Witnesses", substitute "Mr. Z. Kay" for "Mr.D.Kay"
Page 7067,column 1,line 44	Substitute "Mr.Z.Kay" for "Mr.D.Kay"
Page 7067	Strike out last five lines in column 1 and first five lines in column 2, and substitute therefor: "Basically, what I think is involved here is not only the point of justice but indeed parity. What do the social scientists and the humanities people in this country mean? Simply, that we have been lagging far behind. I think it commendable that every individual organization and association has come forward in the hope of making an effective impact upon the members of the committee."
Page 7067, column 2, line 9	Delete lines 9 and 10 and substitute therefor: "Let us look at some of the aspects in this survey, 'Federal Expenditures on Research in the Academic Community.'"
Page 7067, column 2, line 51	Substitute "please God" for "thank God".

Proceedings of the Special Committee
on Science Policy, No. 57
for June 10, 1969

Page 7038	After line 48, add the following: "(b) The above is a decentralized approach to the problem. Simultaneously, the government should establish a central <u>research bureau</u> of the sort mentioned in the last throne speech. This bureau should be independent of all governmental agencies,

and should not be expected to undertake contractual research assignments for government or business. Having an academic orientation, and under the active direction of a stimulating, widely known economist, its primary objective should be to attract young scholars of outstanding potential - - frequently retrieving outstanding Canadian Ph.D.'s from United States graduate schools -- providing them with adequate research facilities and an environment conducive to intensive research on topics of their own choosing, in the hope that they will become intellectually involved in Canadian problems and will ultimately take up positions in Canadian universities. (It must be stressed that we could not expect all fellows of such an institute to remain in Canada. Perhaps a retention rate of 1/3 could be regarded as highly successful)

First Session—Twenty-eighth Parliament
1968-69

THE SENATE OF CANADA

PROCEEDINGS
OF THE
SPECIAL COMMITTEE
ON
SCIENCE POLICY

The Honourable MAURICE LAMONTAGNE, P.C., *Chairman*
The Honourable DONALD CAMERON, *Vice-Chairman*

No. 78

BRIEFS NOT SUPPORTED BY ORAL EVIDENCE:

188. Brief submitted by The National Librarian.

189. Brief submitted by the Pharmacological Society of Canada.

190. Brief submitted by the Association of Deans of Pharmacy of Canada.

191. Brief submitted by SNC Enterprises Ltd., Montreal.

192. Brief submitted by the Ontario Department of Trade and Development.

193. Brief submitted by the Canadian Public Health Association.

194. Brief submitted by the Canadian Nurses' Association.

20680—1

MEMBERS OF THE SPECIAL COMMITTEE
ON
SCIENCE POLICY

The Honourable Maurice Lamontagne, *Chairman*

The Honourable Donald Cameron, *Vice-Chairman*

The Honourable Senators:

Aird
Belisle
Blois
Bourget
Cameron
Carter
Desruisseaux
Giguère
Grosart
Haig
Hays
Kinnear
Lamontagne
Lang
Leonard
McGrand
Nichol
O'Leary *(Carleton)*
Phillips *(Prince)*
Robichaud
Sullivan
Thompson
Yuzyk

Patrick J. Savoie,
Clerk of the Committee.

ORDERS OF REFERENCE

Extract from the Minutes of the Proceedings of the Senate, Tuesday, September 17th, 1968:

"The Honourable Senator Lamontagne, P.C., moved, seconded by the Honourable Senator Benidickson, P.C.:

That a Special Committee of the Senate be appointed to consider and report on the science policy of the Federal Government with the object of appraising its priorities, its budget and its efficiency in the light of the experience of other industrialized countries and of the requirements of the new scientific age and, without restricting the generality of the foregoing, to inquire into and report upon the following:

(*a*) recent trends in research and development expenditures in Canada as compared with those in other industrialized countries;

(*b*) research and development activities carried out by the Federal Government in the fields of physical, life and human sciences;

(*c*) federal assistance to research and development activities carried out by individuals, universities, industry and other groups in the three scientific fields mentioned above; and

(*d*) the broad principles, the long-term financial requirements and the structural organization of a dynamic and efficient science policy for Canada.

That the Committee have power to engage the services of such counsel, staff and technical advisers as may be necessary for the purpose of the inquiry;

That the Committee have power to send for persons, papers and records, to examine witnesses, to report from time to time, to print such papers and evidence from day to day as may be ordered by the Committee, to sit during sittings and adjournments of the Senate, and to adjourn from place to place;

That the papers and evidence received and taken on the subject in the preceding session be referred to the Committee; and

That the Committee be composed of the Honourable Senators Aird, Argue, Bélisle, Bourget, Cameron, Desruisseaux, Grosart, Hays, Kinnear, Lamontagne, Lang, Leonard, MacKenzie, O'Leary *(Carleton)*, Phillips *(Prince)*, Sullivan, Thompson, Yuzyk.

After debate, and—

The question being put on the motion, it was—

Resolved in the affirmative."

Extract from the Minutes of the Proceedings of the Senate, Thursday, September 19th, 1968:

"With leave of the Senate,

The Honourable Senator Lamontagne, P.C., moved, seconded by the Honourable Senator Benidickson, P.C.:

That the name of the Honourable Senator Robichaud be substituted for that of the Honourable Senator Argue on the list of Senators serving on the Special Committee on Science Policy.

The question being put on the motion, it was—

Resolved in the affirmative."

Extract from the Minutes of the Proceedings of the Senate, Wednesday, February 5th, 1969:

"With leave of the Senate,

The Honourable Senator McDonald moved, seconded by the Honourable Senator Macdonald (*Cape Breton*):

That the names of the Honourable Senators Blois, Carter, Giguère Haig, McGrand and Nichol be added to the list of Senators serving on the Special Committee on Science Policy.

The question being put on the motion, it was—

Resolved in the affirmative."

Robert Fortier,
Clerk of the Committee.

BRIEFS NOT SUPPORTED BY ORAL EVIDENCE

The Committee has received many briefs which were not supported by oral evidence given before it. It has been decided to print these briefs separately from the ordinary proceedings, in several volumes, of which this is the first.

The list of briefs printed in this volume is as follows:

188—Brief submitted by the National Librarian

189—Brief submitted by the Pharmacological Society of Canada

190—Brief submitted by the Association of Deans of Pharmacy of Canada

191—Brief submitted by SNC Enterprises Ltd., Montreal

192—Brief submitted by the Ontario Department of Trade and Development

193—Brief submitted by the Canadian Public Health Association

194—Brief submitted by the Canadian Nurses' Association

ATTEST:

Patrick J. Savoie,
Clerk of the Committee.

APPENDIX 188

BRIEF

submitted by

The National Librarian

to

the Senate Committee on Science Policy

Ottawa, June 1969

INTRODUCTION

1. This brief is divided into three parts. The first part describes the services presently provided by the National Library of Canada to other libraries and to individuals. The second part reviews some of the major problems that face Canadian libraries today, especially those which concern the National Library. The third part submits recommendations with a view to increasing the efficiency of the services rendered by the National Library and to better coordinating library services on a national basis.

I - PRESENT SERVICES

2. The National Library of Canada is a young institution. It was established on January 1, 1953 when the National Library Act (R.S. 1952, C.330) became effective. (Appendix A) It then absorbed the Canadian Bibliographic Centre, which consisted of 14 positions and had been in existence since 1950 to prepare for the new institution and start it on its way. The Secretary of State was designated as the Minister responsible for the administration of the National Library.

3. The National Library Act provides that:

"10. Subject to the direction of the Minister, the National Librarian may

(a) undertake the collection, by purchase or otherwise, of books for the Library,

(b) compile and maintain a national union catalogue in which the contents of the principal library collections throughout Canada may be listed,

(c) compile and publish a national bibliography in which books produced in Canada, written or prepared by Canadians or of special interest or significance to Canada may be noted and described,

(d) lend, sell or otherwise dispose of books forming part of the Library, and enter into exchange agreements with libraries and other institutions both in Canada and elsewhere, and

(e) generally supervise and direct the work of the National Library in such a manner that the facilities of the Library may be made available to the Government and people of Canada to the greatest possible extent consistent with the sound administration of the Library."

The Act also provides for the dépôt légal, the appointment of an Advisory Council and the setting up of a special account for the purpose of acquiring books (the National Library Purchase Account).

4. In 1964, on the recommendation of the National Librarian, the Secretary of State wrote to the President of the National Research Council to suggest that the responsibility of providing nation-wide library services in the fields of science and technology be formally delegated to the library of the National Research Council and that the latter be given the status of a National Science Library. This was confirmed by statute when the Research Council Act was amended in 1966 (14-15 Elizabeth II, c.26). Furthermore, in 1966, the latter was also commissioned to set up a national bibliographic center for medical sciences and health. The National Library and the National Science Library make every effort to avoid any unnecessary duplication of resources and services and they cooperate in areas of common interest. They also avoid duplicating the collections of such large government libraries as those of the Department of Agriculture, the Geological Survey or the Dominion Bureau of Statistics. Such a division of functions allows each one to provide better services to the government and to the people of Canada.

5. The National Library of Canada is the most recent of the large federal libraries. It had a modest beginning in cramped quarters, and its early development was somewhat retarded due to the lack of staff, space and resources. It now has a permanent location, a large, beautiful, functional and well-equipped building, which has improved the efficiency of the basic services established under the direction of the first National Librarian, and aided in the recruitment of the staff which grew from 14 in 1952-53 to 233 in 1969-70. The National Library is discharging the essential functions of a national library, i.e. the collection of the nation's literature, the publication of the national bibliography and the maintenance of a national union catalogue, as well as other desirable functions which will be mentioned hereunder. Within sixteen years of its founding, the National Library of Canada has become the main bibliographical information center of the country.

Follows a brief description of the principal services provided by the National Library:-

(a) the national bibliography

6. The National Library Act established the dépôt légal and from then on, current Canadian publications were deposited at the National Library. The publication of the National bibliography is naturally related to the practice of the legal deposit, and Canadiana included at the outset books and pamphlets. Published monthly and cumulated annually, it extended its coverage, as staff permitted, to include other types of publications and library materials. It now lists and describes books, pamphlets, new periodicals, new newspapers, printed music, microforms, films and filmstrips, federal and provincial government publications. Included also are books by Canadian authors published abroad, and foreign publications dealing with Canadian subjects. Canadiana renders

immeasurable services to other libraries, which use it as a guide both for purchasing and for cataloguing. It is sent free to all Canadian libraries, and hundreds of foreign libraries receive it, either on exchange, as a gift or by subscription. The mailing list at the end of the last fiscal year stood at 2,992 libraries and individuals, 900 of them in 57 foreign countries. For libraries which wish to obtain this bibliographic information sooner, a weekly proof service is available. The Library of Congress uses the entries in this proof service to acquire items, to list them in its own library catalogue, in its published National Union Catalogue and for its printed cards service. Canadiana is not only an essential service provided to Canadian libraries, it also contributes to making Canadian publications better known and more widely used abroad.

7. The National Library supplies annually to UNESCO statistics on Canadian book production (for publication in UNESCO Statistical Yearbook and in the United Nations Statistical Yearbook), and a report on "National Bibliographical Services and Related Activities" in Canada (for publication in UNESCO's bulletin Bibliography, Documentation, Terminology and in its Bibliographical Services Throughout the World.) The National Library also compiles for UNESCO's Index translationum the annual list of translated books published in Canada. Thanks to Canadiana we now have an official, and virtually complete, national bibliography for the last eighteen years. Reasonably comprehensive bibliographies of Canadiana up to 1867 also exist. The National Library has almost completed also a bibliography of all Canadian publications from 1867 to 1900, containing more than 25,000 titles, which should be published in 1970 or 1971. The National Library has also done some preliminary work on bibliographies to cover the period 1900-1950. It has also subsidized the publication of

A check list of Canadian imprints, 1900-1925
Catalogue d'ouvrages imprimés au Canada, compiled
by Dorothea D. Tod & Audrey Cordingley. (Ottawa, 1950)

Stephen Leacock, a check-list and index of his writings, compiled by Gerhard R. Lomer. (Ottawa, 1954)

Publications of the governments of Nova Scotia, Prince Edward Island, New Brunswick, 1758-1952, by Olga Bernice Bishop. (Ottawa, 1957)

Publications of the government of the Province of Canada, 1841-1867, by Olga Bernice Bishop. (Ottawa, 1963)

"Bibliographie de la danse théâtrale au Canada" par Pierre Guilmette. (In preparation)

8. To supplement the information contained in _Canadiana_ and other bibliographies, the National Library makes known and available the results of Canadian graduate research, through the publication annually of _Canadian Theses, Thèses canadiennes,_ listing theses accepted by Canadian universities for graduate degrees, arranged by subject, by university and by author. This publication began with the academic year 1960-61, and the National Library has in preparation a retroactive list of Canadian theses for the years 1947-1960, which will fill the gap between _Canadian Theses_ and the list published by the Humanities Research Council of Canada and the Canadian Social Science Research Council which covers the years 1921-1946. The theses reported in the annual list reflect the growth of graduate studies in Canada, as the following table shows:

Academic year	1961/62	1962/63	1963/64	1964/65	1965/66	1966/67
Doctorates	317	407	449	528	686	719
Other	1443	1652	1890	2101	2465	2586
	1760	2059	2339	2629	3151	3305

Beginning in 1963, the Branch initiated the "Canadian Theses on Microfilm Service". This is a service by which the National Library publishes on microfilm, at cost, any or all theses which a university chooses to have so published. The microfilms are

listed in Canadiana and are for sale at .10 per foot. The price is usually less than $5.00. At March 31, 1969, 3331 theses had been published on microfilm and 3075 sales were made. Participating universities are British Columbia, Calgary, Carleton, McGill, Manitoba, New Brunswick, Alberta, Queen's, Simon Fraser, Toronto, Western Ontario and York. The National Library retains the negative to reproduce positives for sale and adds a positive to its own shelves for use by the library clientèle or for interlibrary loan.

Finally, the National Library has paid since 1951 for the printing of the annual cumulation of the Canadian Periodical Index compiled and published monthly by the Canadian Library Association.

(b) the national union catalogue

9. Researchers, whether they are working in the scientific and technical field or in the social sciences and the humanities, whether they are in universities, in industry or in the public service, need to use material which is in collections other than those of the libraries in which they are conducting their research. When this occurs, requests for interlibrary loans are sent to the libraries which have the needed material. Before the national union catalogue was started in the National Library, requests for interlibrary loans frequently had to be sent to two, three or more libraries before the material could be located. This was a slow, expensive and time-wasting process and was a great inconvenience to the researcher. The holdings of 305 Canadian libraries (including those of all universities and of all government departments and agencies) are now represented in the National Union Catalogue, with 223 libraries actively reporting at present. They cover every subject field and all types of material (books, serials, government documents, manuscripts, etc.) and there is only one central source to which libraries and researchers anywhere in Canada, and in the world,

can apply for Canadian locations of publications in all subject fields. This centralized location service provided by the National Library produces the following results: (1) one application, rather than several requests, to be sent by the borrowing library; (2) material is located more quickly and the National Library either lends the material itself or forwards the request to the lending library; (3) when the needed material is not located in Canada, the National Library relays messages via TWX to the Library of Congress which provides quick access to the resources of American libraries. This centralized service results in much quicker receipt of interlibrary loans, which speeds up and improves the research being conducted in all fields of knowledge. Compilers of bibliographies listing library holdings are now able to find the record of the library collections in one place and need not travel to many libraries nor send them questionnaires. The National Union Catalogue now contains more than 10,000,000 cards representing more than 14,000,000 volumes and grows currently at the rate of 4,500 per day. In 1968-69, the National Library was asked to locate 81,325 titles, an average of 373 per day, and was able to find 64,187, that is some 80 per cent in Canadian libraries. Almost 50 per cent are received, and answered, via the Telex network through which some 60 Canadian libraries can communicate rapidly with one another; the other half by mail, by telephone or in person. One can appreciate the increasing usefulness of the National Union Catalogue by the number of location requests answered in recent years: 29,793 in 1964-65; 39,062 in 1965-66; 49,056 in 1966-67; 57,633 in 1967-68, and 81,325 in 1968-69.

10. These location requests would come in much greater number, were it not for the Union List of Periodicals in the Social Sciences and Humanities currently received by Canadian Libraries, published in 1967 by the National Library, which permits the rapid location of some 12,000 titles currently received by 179 Canadian libraries. Also useful is the

Union List of Non-Canadian Newspapers held by Canadian Libraries, compiled by Mr. Stephan Rush and published by the National Library, in which are listed newspapers of 60 countries received by 120 Canadian libraries. Such lists, together with the Union List of Scientific Serials in Canadian Libraries put out by the National Science Library, go a long way to reduce the number of location requests received by the National Library and to speed up research in most subject fields. A Union List of Canadian Newspapers is in preparation covering both dead and current newspapers; it is expected that it will be ready for publication in 1974.

11. Since 1959, the National Library reports to the Library of Congress holdings of selected non-Canadian, non-American titles for inclusion in the Library of Congress National Union Catalogue. A large percentage of British and European publications so reported is not to be found in any American library, or in very few only. Similarly, since 1956, the National Library reports to the Library of Congress Canadian holdings or serials which started publication after December 31, 1949, for inclusion in its union catalogue of serials called New Serial Titles, a monthly publication, with cumulations, to which most of the larger Canadian libraries subscribe. There are in Canada smaller local union catalogues, such as the Nova Scotia Provincial Union Catalogue in Halifax, the Metropolitan Bibliographic Centre Union Catalogue in Toronto and the University of Toronto Union Catalogue, but the National Library is the main bibliographic centre serving Canadians, as well as the centre for information concerning Canadian publications and for international borrowing and lending. Its operations are both national and international.

(c) The National Library Collection

12. The effort to provide public service from the beginning by publishing Canadiana, by compiling the national union catalogue and by compiling and publishing union lists and other

bibliographies, as well as the want of a suitable building made it difficult, if not impossible, for the National Library of Canada to build up a strong collection and even to catalogue its rather limited collection of books and periodicals. There was little opportunity to put the house in order. The collections of the Library are far from fully processed and are therefore not readily or completely available for use. At March 31, 1969, there were 149,466 titles catalogued by author and title, of which about 40 per cent had been given full subject treatment in the classed catalogue. Also fully catalogued were 4,667 microfilms. The transfer of some 300,000 volumes from the Library of Parliament after the fire in 1952 created a demoralizing backlog almost from the outset; however, in order to make this collection available before it is fully catalogued, an in-process catalogue by author has been set up, listing over 100,000 titles, and this is useful although it does not permit a subject approach. The National Library collection also includes more than 100,000 government publications not yet catalogued, shelved by issuing department or agency, except 3,894 current serials which are recorded in the Government Documents Kardex; it includes also more than 22,000 periodicals, not yet collated, except the 7,000 titles currently received and recorded in the Serials Kardex. There are also 9,800 linear feet of duplicate periodicals and government publications in the valuable shelf space in the National Library building, and some 3,900 boxes of books, periodicals and government publications in dead storage in another building. In addition, an average of more than 20,000 items is received each month from other libraries, and the National Library is faced with a growing backlog of unorganized material which, because of lack of staff, remains inaccessible and cannot be used locally nor made available to those libraries which need it. With such a large proportion of unorganized material in storage or not yet processed,

less than half the National Library collection can be put to good use at the moment. Last year, interlibrary loans totalled 8,550 and these were supplemented by thousands of Xerox copies. Furthermore, it is impossible to embark upon a large and systematic acquisitions programme, except for Canadiana, reference material and new publications. Until this unorganized material is unpacked, arranged on shelves and catalogued, there is danger of spending many thousands of dollars for books or serials which might already be in the collection but are still unknown to the staff.

13. Fortunately, the National Library has a good reference collection, a reasonably good collection of Canadiana, including the best collection of Canadian newspapers and probably the most complete collection of Canadian phonorecords, more than 3,500 of them, representing chiefly music composed or performed by Canadians, dating from the beginning of the century. A well-equipped audition room insures that discs and tapes may be listened to under the best possible conditions. Exchange programmes, such as those with Australia for current material in the social sciences or with the Sorbonne for French theses against a selection of Canadian learned journals, are few and limited. In addition to current publications suitable for scholarship, the National Library has collected back files of periodicals in the social sciences not held elsewhere in Canada, including reprints of source material in microforms. To say that the National Library of Canada has a good collection in subject fields other than those mentioned above would be an overstatement. It may be of interest to mention also that the National Library has few publications in languages other than English and French, except in the reference collection, but that present members of the staff are proficient in the following languages: Anglo-Saxon, Chinese, Danish, Dutch, German, Hebrew, Hindi, Hungarian, Italian, Latin, Norwegian, Polish, Punjabi, Russian, Sanskrit, Spanish, Swedish, Ukrainian and Yiddish. When recruiting additional staff, priority will be given to suitable applicants with knowledge of Japanese, Portuguese and other languages.

(d) the Office of Library Resources

14. The establishment of an Office of Library Resources in the National Library was first proposed by the Canadian Library Association and recommended later by the Canadian Association of College and University Libraries, as well as in the Williams Report and in the Downs Report, in which the functions of such an office were discussed in some detail. An Office of Library Resources was established in the National Library on January 1, 1968, and it presently consists of one person. The functions of the Office could be many, and they will be more fully discussed in the second part of this brief. Briefly, they are to assemble and keep up-to-date information on library research collections and acquisition plans; to encourage the coordination of collecting activities in the country, and to plan the acquisitions programme of the National Library, while keeping in mind the resources of other research libraries. In its first year of operation, the Office conducted detailed surveys of the collections of seven university libraries. The Office has also started on a study of international exchanges of official publications at the federal level so that policies and practices in this field could be reviewed cooperatively by the principal agencies concerned, i.e., the Department of External Affairs, the Public Printing and Stationery Department, the Library of Parliament and the National Library. No serious effort was made as yet to coordinate collections at the national level, but, at the suggestion of the National Librarian, the Association of Universities and Colleges of Canada appointed recently a Committee consisting of university administrators, deans of graduate studies and librarians to study the interrelations between the coordination of library resources and the rationalization of higher studies and research, as well as the coordination of electronic processing and information retrieval systems. This will be discussed later in the brief.

(e) varia

15. In addition to the principal functions described above, the National Library has distributed duplicates - books, pamphlets, periodicals, newspapers, official publications - to other libraries; it has microfilmed the 1204 items listed in Marie Tremaine's Bibliography of Canadian Imprints, 1751-1800, and these rare and valuable early Canadiana are now available on microfilm to other libraries for as little as $175. The National Library has also given professional and technical advice to other libraries, especially to government libraries. In collaboration with Dr. Jack E. Brown, Chief Librarian, National Science Library, Dr. W. Kaye Lamb made a study of federal government libraries in Ottawa (Appendix B). In the beautiful display rooms now available in the new building, the National Library is also organizing exhibitions, some of them in cooperation with the Public Archives: these have a definite educational value.

16. The National Library of Canada was built on firm foundations, and it is now performing the essential functions of a national library. It should continue to carry on the task that has been undertaken, building even higher a structure that is already impressive. It is not an island unto itself, however, and its future development should be planned and implemented in accordance with developments in Canadian libraries, and indeed in foreign libraries too. Close liaison must be maintained with many other institutions in order to avoid unnecessary duplication of efforts, and to make sure that the services of the National Library supplement those of other libraries, wherever possible and desirable. It is indeed impossible to discuss the future of the National Library, or to re-examine its role, unless it is considered as the very centre of a national network, and as a part of international library networks. The global library situation in Canada should

be taken into account when plans are designed for the improvement of the services provided by the National Library, and priority should be given to those projects which are likely to meet the most pressing needs. Your committee already heard much about the magnitude and the variety of those needs; those which appear to be the most serious will be recited once more here, in the second part of this brief, so as to provide a foundation for the comments and suggestions which will be offered in the third part.

II - SOME LIBRARY PROBLEMS IN CANADA

(a) General comments

17. National library associations and many institutions and individuals submitted to your committee their views and comments on problems that face libraries in Canada to-day. Available also for reference are several published reports of commissions of enquiry and special surveys, some general, some specialized; some national, some regional or local, dealing with library resources and services in this country. Also informative are annual reports of libraries, of regional or provincial library systems or services, DBS surveys of libraries, as well specialized studies of various aspects of library work. By way of example, one could mention the St. John Report on Ontario libraries (1965), the Vainstein Report on British Columbia Libraries (1966), the Downs Report on the Resources of Canadian Academic and Research Libraries (1967), etc. When one examines these reports and surveys, one may form a notion of the magnitude and complexity of the problems involved in library developments, as well as of the regional disparities which exist in the area of library services as they do in so many other fields.

18. It is impossible, however, with the limited information now available on many aspects of library development

in this country, to attempt to draw a complete picture of the library world in Canada. Such a picture should include public libraries, school libraries, college and university libraries, government libraries both provincial and federal, special libraries, in all ten provinces and in Ottawa, that is public as well as private institutions, administered under federal or provincial statutes, or governed by municipal by-laws, or privately managed. No survey encompassing all types of libraries in all parts of Canada was ever made, and recent endeavours by the Canadian Library Association to obtain funds with a view to conducting such a comprehensive study completely failed. At the annual meeting of the Association held earlier this month in Newfoundland, the ad hoc committee appointed to investigate the feasibility of such a survey reported that financial support was not forthcoming and recommended that the proposal be dropped. It recommended also that, in spite of serious gaps in the coverage, "surveys of libraries in Canada made in recent years be examined with a view to extracting significant data for consolidation in a compendium on the state of the library arts". It is quite out of the question to attempt such a consolidation here; much of the information scattered through many reports is more or less obsolete. All that is possible, and desirable, is to try to identify those problems faced by Canadian libraries in the solution of which the National Library takes, or could take, an active part. In point of fact, those are library problems to which your committee is addressing itself.

19. Before doing so, however, it is advisable to state clearly that the services of the National Library are available to any library in Canada, and that we are concerned about those disparities to which reference was made above, although there is nothing much that could be done by the National Library in order to correct them. Public libraries, for instance, are operating under provincial laws, and current operating payments

in 1966 amounted to $1.74 per capita for Canada as a whole. These payments vary considerably from province to province, that is from $0.54 to $2.72 per capita, which shows how great the inequalities are. Many remote or poverty-stricken districts have no library facilities at all. Such disparities exist also in respect of school, college or university libraries; and indeed of government libraries too. There are many situations and problems about which Canadian librarians are seriously concerned; your committee will undoubtedly hear about some of them from library associations and other groups.

(b) Research libraries

20. Many of the reports alluded to above deal with research libraries. Some of them - Simon, Bonn, Tyas - are restricted to problems of scientific and technical information. Some other - Ridington, Massey, Williams, Ostry, Downs, Macdonald - cover areas with which the National Library is directly concerned. As underlined in the recent Macdonald Report, all these surveys emphasize the inadequacy of library services in Canada. All of them emphasize strengths, weaknesses and problems, and they all submit recommendations aimed at improving the situation. A great deal of progress was achieved since 1933, when the Ridington Commission found the situation to be "discouraging, difficult and well-nigh hopeless", but needs are much greater to-day, and much remains to be done before we have in Canada a library network capable of providing the research community with the kind of library support it deserves.

21. The Williams Report (1962) noted that "except in Canadian subjects and in mediaeval studies, there are no collections in major fields that are outstanding as a whole". In spite of the definite impact the Williams Report has had on the development of university libraries in recent years, this remains a valid diagnosis to this day. The Bladen Report (1965) stated that "one of the most serious deficiencies in the

research equipment of this country lies in the inadequacy of its libraries". Two years later, the Downs Report found library holdings to be still deficient. When it appeared before your committee on March 12, 1968, the Canada Council reiterated that "the major issue related to the adequate tooling of social and humanities research in Canada is undeniably that of the present state of our university library collections. This is the fundamental and most dramatic shortcoming of Canadian research institutions .... " This is a serious situation, for (as the Macdonald Report has it) "all significant research is in some measure dependent upon library resources . . . As for the humanist and social scientist, his dependence upon library resources is virtually continuous". The Macdonald Report (1969) then comments: "all the published reports (except the two which, because of their terms of reference, restrict themselves to provincial matters) have a second thing in common: they all see the situation as having a national, as well as provincial and local aspects, and they all .... identify a Federal Government responsibility". And, except those which are restricted to the fields of science, technology and health, they all make recommendations concerning the functions of the National Library. Most of the earlier reports dealt principally with surveys of research collections; the most recent ones also emphasize the inadequacy of research collections in Canada, but they also supply much information on the nature and scope of services performed by libraries and they make definite recommendations aimed at improving, and coordinating better, these services through the progressive application of automation to library processes.

22. The major problems that face Canadian research libraries to-day can be grouped under two main headings:
(a) the improvement and coordination of research collections; and
(b) the improvement and coordination of library systems and services

(c) Research collections

23. Several surveys of research collections in the fields of the social sciences, the humanities and the arts were conducted since 1947 when Watson Kirkconnell and A.S.P. Woodhouse, in The Humanities in Canada, deplored "the isolated fragmentation of our resources", and recommended the establishment of a national library and the creation of a national union catalogue. They listed 80 North American university libraries which had holdings of more than 200,000 volumes; only four of them were in Canada: Toronto, McGill, Laval and Queen's. Fifteen years later, Edwin E. Williams conducted, for the National Conference of Canadian Universities and Colleges, a survey of the Resources of Canadian University Libraries for Research in the Humanities and Social Sciences (1962). The report showed that there were no outstanding collections, except in Canadian subjects and in mediaeval studies. As mentioned above, the Williams Report had a definite impact on university administrators, and university libraries expenditures have more than doubled in the past five years. This is also true of their book expenditures, and in recent years, several Canadian university libraries have had book budgets comparable to those of large university libraries in the United States. Commenting on this substantial growth, the Downs Report concluded: "At this rate, Canadian university libraries will soon make up for any ground that they may have lost by a late start". The Downs Report (1967) provided us with additional information on many specialized collections in Canadian libraries. When the report was made public at the Libraries for Tomorrow Conference in Montreal, in April 1968, it was agreed that the first task of the Office of Library Resources, established earlier that year in the National Library, should be to "make detailed studies of the extent of scholarly collections in Canadian libraries" in order to bring the Williams Report

up-to-date. As reported earlier in this brief, this is being done, but it will take one to two more years before we have a detailed library map of Canada, a complete inventory of research collections which would show strengths, weaknesses, overlappings and gaps. No cooperative scheme could be devised without such a preliminary census.

24. The Office of Library Resources could be either an information centre assembling, keeping up-to-date and disseminating information concerning research collections in Canadian libraries, or a coordinating agency administering, in cooperation with libraries willing to enter into a cooperative scheme, as complete a plan as possible for the rationalization of acquisitions on a national basis. The extent to which the coordination of library collections can be achieved depends principally on the extent to which the institutions they serve agree to define and rationalize their programmes of higher studies and research. Whether or not universities, for instance, agree to such rationalization librarians have, and will continue to have nevertheless a certain measure of responsibility for developing the research collections confided to their care, in a cooperative way, within the limitations imposed on many by the academic community they serve. It is obvious that university librarians could not enter into firm agreements in respect of cooperative schemes unless the universities themselves agreed to a similar specialization of subject coverage in university programmes. Academic freedom must be preserved and any cooperative plan should be acceptable to the participating institutions, if it is to be successful at all. The National Library of Canada cannot dictate policies to other libraries, still less to universities. It can provide, however, the necessary machinery to coordinate such collective efforts.

25. Indeed, it is impossible for the National Library to formulate a comprehensive acquisitions policy, at this time.

This will not be possible until we have a better knowledge of the collections of the larger research libraries, as well as of their plans, so that we may supplement them in every way possible and duplicate them only when and where it is advisable to do so. This knowledge we lack at the moment, and we will lack for some time yet. Your committee will appreciate then how important it is to us to see established in this country some form of cooperation in the field of acquisitions, however limited it may be at first.

26. With the explosion of printing, Canadian libraries must be selective, and not attempt to be comprehensive in their concerted efforts to build up a strong national collection for scholarship. Even the United States no longer aims at collecting comprehensively the literature of the world, which cannot be envisaged any longer but as a world-wide project involving many nations. Recent surveys have disclosed that large parts of collections in the larger American libraries are never used, and that some of these unused collections are more than duplicated in many cases. Canada is a country still so poor in books that we cannot very well hope to make up for the time lost unless we all agree to pool our resources, to coordinate our programmes and to work more cooperatively than ever before to provide better library services to Canadians. Otherwise, we shall waste a substantial part of our funds, efforts and resources through sheer waste and we shall not provide our clientele with the best possible service to which it is entitled. This, the National Library cannot achieve alone.

27. Some efforts are being made to rationalize higher studies, research and library developments on a provincial or regional basis. Your committee is familiar with the achievements of such groups as the Ontario Council of University Librarians, the Conseil des Recteurs des universités du Québec, the Association of Atlantic Universities and the Librarians of Western Canadian Universities. Cooperation on a provincial or

regional basis is undoubtedly fruitful and should continue. It would appear, however, that nothing short of a national plan could maximize the benefits to be derived from the money Canadians invest collectively in the purchase of books for research purposes. And the benefits of a national approach should be fully assessed. Such a study was undertaken recently by a committee appointed by the Association of Universities and Colleges of Canada, consisting of university administrators, deans of graduate studies and librarians, to study the problems involved in the coordination of collection of research material on a national basis. This AUCC Committee will address itself to such questions:

1. Should the Office of Library Resources be merely a clearing-house for the exchange of information on research collections, or should we endeavour to develop and administer a national plan for the coordination of collecting activities?

2. In either case, what are the procedures and techniques best suited to conduct, and maintain up-to-date a survey of library resources, and to communicate its findings to interested libraries?

3. Should we agree to develop some sort of a Farmington Plan for Canada, as recommended by Downs, should it be administered by the National Library or by some other body or association?

4. Should such a plan be comprehensive, or should it be limited (at least in its original phase) to certain subjects, or countries, or languages? or to certain categories of material such as official publications, serials or microreproductions?

5. If the National Library should be given the responsibility of establishing such a plan, should its role be purely advisory, or should it be managerial, too? In the latter case, would other institutions agree to enter into firm agreements to assume definite responsibilities for certain areas?

6. Is it preferable to endeavour to develop a national scheme, or should the National Library merely coordinate, as best it could, provincial or regional schemes?

7. To what extent is it realistic to endeavour to establish a national plan, as long as higher studies and research are not better rationalized at both the provincial and national levels? How best could this committee tackle the problem of identifying to the responsible authorities (universities and governments) the serious shortcomings of any effort libraries may make with a view to better coordinating their research collections until there is a parallel endeavour to rationalize higher studies and research?

8. To what degree, and in what respects, any national scheme should take into consideration the availability to us of the large library resources of American libraries, and of such centres as the Center of Research Libraries in Chicago? In what areas should Canada aim at being self-sufficing, and to what extent should we count on American libraries to supplement our collections?

9. To what extent, and in respect to what categories of information, is any such plan likely to be affected by the introduction of new technology in library operations: computer, microforms, tele-facsimile, etc? What is likely to be the impact of an automated national union catalogue on such plans? Pilot projects and feasibility studies should be initiated and analyzed before any attempt is made at arriving at any conclusions.

28. The recommendations of this AUCC Committee, as well as those of such major reports as Downs' and Macdonald's, should have an impact on those who have the responsibility of planning the future development of research libraries in Canada. In this respect, mention should be made here that the Downs Report suggests that "it would be appropriate, therefore, to re-open the question of a Farmington Plan for Canada", and warns that "lacking such a rational plan, the libraries may duplicate unnecessarily while omitting coverage of important materials". Similarly, the Macdonald Report recommends the adoption of "an integrated national acquisitions program" as it does "a nation-wide system of research libraries". It would appear that the consensus of opinion is now that the magnitude and complexity of the problems faced by Canadian libraries to-day require a national approach. One should hope also that, if the

four Scandinavian countries were able to establish a cooperative plan for the acquisition of foreign publications for research, it should be possible to achieve the same degree of cooperation within one federal state. Finally, if the richest country in the world came to the conclusion that the collecting of research material required cooperation on a national basis, it would appear that a national plan is even more necessary in a much poorer country like Canada.

(d) Library systems and services

29. One cannot judge the strength of a library only by the size of its collection. Unless it is properly catalogued and classified, a great deal of material cannot be used; not enough periodicals are indexed, and no abstracting services are available for research in the humanities and the social sciences, comparable to those in the fields of science, engineering and medicine. Another criterion in judging a library is the quality of its staff. One of the leading authorities on information systems, B. W. Adkinson, Head, Office of Science Information, National Science Foundation, Washington, D.C., wrote recently: "There is a certain lack of realism about what automation can do. For housekeeping detail, record keeping, and even manipulating files as an aid in searching through them they are probably invaluable. The day when they will provide a complete reference service without human intervention is still far down the road." (Federal Legislation for Libraries, Champaign, Ill., 1967, p. 63). Technical services exist in libraries in order to make the material readily available. The quality of these services rests finally on the skill of the staff. This needed to be said at least once in a brief in which the attention centres on collections and systems.

30. The shortage of librarians, especially of competent librarians, is likely to continue, unless the status of the professional librarian is fully recognized and salaries become competitive with those in comparable professions. It will be

difficult for library schools to recruit the best-qualified students for the library profession, if salaries remain less attractive than those paid to other groups such as teachers or archivists. In the last analysis, those who would suffer most from a lowering of the present level of technical and readers' services would be the research community. "As libraries rise in prestige in the academic world, the Downs Report remarked, college and university administrators are discovering that competent professional librarians are in exceedingly short supply. Simply having the money to develop a strong library may not be sufficient. Recruiting a staff means going out into a seller's market and meeting strong competition. The library schools are unable to fill the gap between supply and demand". Furthermore, in the larger or specialized research libraries, there is a definite need of specialists holding two graduate degrees, one in library science and the other in a special subject field. There is also a growing need now for systems analysts, programmers and other types of subprofessional personnel trained in the new information techniques. The library world is now going through a major technological revolution, and library personnel must adjust to new problems and methods.

31. The technological revolution does not modify substantially the basic functions of the modern library. A card catalogue is a data bank, it is an information retrieval system. The processing of library matter - books, pamphlets, periodicals, newspapers, documents, manuscripts, microforms, phonorecords, tapes, etc. - includes many clerical functions of a routine nature. It is in this area that the introduction of automation is now technically and economically feasible in large libraries. The Downs Report mentions the following operations as those best suited to computerization now: "interfiling entries in a catalogue, ordering books from publishers, ordering printed catalogue cards, preparing serial

records lists, monitoring circulation operations, printing book catalogues, and analyzing services to readers". Other current applications of automation to library operations are budget and accounting, binding records and inter-library loans. Another technological development of recent years is the electronic facsimile transmission of the printed word, or telephotography. The explosion of printing and of research made the introduction of automatic processes into large libraries a necessity. Owing to growing pressures and strains in many of its operations, the Library of Congress began to study potential applications of automation some ten years ago. In 1961, the Council on Library Resources, Inc., made a grant to the Library of Congress for completing such a study from the point of view "of a research library whose activities are interrelated with those of other research libraries". This survey was completed in 1963, with the publication of Automation and the Library of Congress, frequently referred to as the King Report. The main benefits of the automation of the Library of Congress were summarized in the King Report as follows:

> Some specific short-range benefits of automation will be to:
>
> 1. Accelerate the acquisition and processing of library materials and permit effective file monitoring.
> 2. Increase the reliability and completeness of response to requests.
> 3. Decrease the effort of user and librarian in the search for information and simultaneously provide more rapid service.
> 4. Accelerate the production of bibliographies and other library publications.
> 5. Provide greater assurance of the integrity of the collections.
> 6. Permit increased depth of indexing.
> 7. Improve the efficiency and reduce the cost of serial record control, circulation control, and other record-keeping functions.
>
> The most important longer range benefits will be to:
>
> 1. Increase use of libraries in support of nationwide endeavors.

2. Service information requests of greater complexity and with a higher degree of responsiveness than is currently possible.

3. Create information compendia tailored to the user's needs.

4. Enhance interlibrary cooperation and secure for the individual user the benefits of the community of library resources.

32. The Library of Congress has designed since an overall plan for the automation of its central bibliographic system. Several of its housekeeping operations are now automated. It established in 1967 an office to collect and disseminate information about library automation programs. Last year, the Card Division (which sold 78,767,377 cards to other libraries) was mechanized. MARC tapes are now available (bibliographic data in machine-readable form) and the MARC format was accepted by the three US National Libraries as the standard format for the communication of bibliographic information. The three US National Libraries established last year a Task Force to direct and coordinate the development of their automation programs. The British National Bibliography is also available on tape in a format compatible with MARC. Similar developments are taking place in European countries, especially in Germany. Nothing comparable has developed in Canada as yet, except for modest beginnings in several universities in the areas of book ordering, serials control, federal government publications control, preliminary listing, indexing, information retrieval and, above all, monitoring circulation and inter-library loans. Several Canadian research libraries do, however, make extensive use of foreign-produced services, especially in the fields of science, medicine, engineering and technology. Your committee already heard a great deal about these developments from many institutions, associations and individuals, and these are beyond the terms of reference of the National Library which does not duplicate services provided by the National Science Library. There is as great a need for parallel control and dissemination of information in the fields of the humanities, the social sciences and the arts.

33. It is no less urgent to coordinate services and systems than to rationalize collections. Accordingly, in September 1968, I requested the Bureau of Management Consulting Services to conduct a preliminary study of the functions of the National Library to determine whether or not the potential benefits of electronic data processing in the areas of acquisition, cataloguing, circulation and reference were great enough to justify a full scale feasibility study. The Bureau had participated in the development of the automated technique used to prepare the index to Canadiana for press. This pilot project has provided members of the Cataloguing Branch with valuable experience in data processing, especially in the filing of bibliographic material by computer. I requested the Bureau to delay the study of the automation of the full text of Canadiana with a view to making sure that the treatment given to publications listed in the national bibliography be fully compatible with systems and formats which could be developed in other areas. Before automating any of its major operations, the Library deemed it advisable to examine in detail its policies, functions and methods with a view to designing an integrated information system. The preliminary study was completed on December 11, 1968 and it recommended that a full scale feasibility study be conducted jointly by the Bureau and the National Library.

This study was initiated without delay and it encompasses all areas of the Library's activities. It will determine the potential benefits of electronic data processing in the areas of acquisitions, accounting, cataloguing, listing, indexing, circulation (including inter-library loans), bibliography, reference and communication. Current trends in automation are studied, especially in the major research libraries and bibliographic centres in Canada and in the United States with which the National Library is more closely associated. Exchanges of information will also take place with major libraries in Britain, France, Belgium and Germany. The study is conducted by a team of librarians and systems analysts, and it is expected that it will

be completed early in 1970. The system design will incorporate, wherever feasible and practical, automatic processing methods, as well as improved, simplified manual procedures. In view of the magnitude of the problems involved, a separate feasibility study of the computerization of the National Union Catalogue is being conducted. Implementation of the system will then develop as staff and financial resources become available.

34. The Study team also works in close cooperation with the AUCC Committee referred to above. Indeed, it acts as the clearing-house for the committee. It also benefits from exchanges of technical information with members of the Tyas Study Group. Visits were paid to Washington, and more will come. Exchanges of technical information are continuing with European libraries, and discussions will take place within the next three months with the national libraries of Britain, France, Belgium, Germany, Italy and Scandinavian countries. The AUCC Committee, and visits to other libraries in Canada, provide opportunities for useful exchanges of views and information. These contacts help us to find how best we could assist other Canadian libraries, as we are told more clearly, and in more concrete terms, what our colleagues expect of us. The Study Team also studied, analyzed and tabulated all previous surveys, and it is currently examining the Macdonald Report. At first sight, I fully agree with most of those recommendations of the Macdonald Report which deal with the functions of the National Library. They are already the stated policy of the National Library. I welcome the fact that the Macdonald Report recalls that all previous surveys "see the situation as having a national, as well as provincial and local aspects, and they all....identify a Federal Government responsibility"; that they all stress the need for the National Library to give leadership in library matters. The earlier reports recommended, and the more recent ones welcomed, the establishment of the national union catalogue which, with the national bibliography, is the most important service provided by the National Library. Williams was, of course,

over-optimistic when he said, in 1962, that the national union catalogue was "now nearly complete". The Macdonald Report is, in my opinion, equally wrong in its pessimistic appraisal of what is disparagingly referred to as a "so-called union catalogue" which, it is suggested, could more accurately be called a "National Selective Locations Searching Service". We are aware of the shortcomings of that catalogue and we are taking steps in order to consolidate and fully edit more entries with a view to eventually automating its operations. There is no doubt in our minds that this catalogue should be machine-readable and we are not surprised to hear the Macdonald Report so recommend, for this is now a self-evident truth.

35. What is annoying, however, is the fact that the Macdonald Study Group arrived at such a conclusion by making what I consider to be a bad use of the wrong statistics. They write that the "limited coverage of the National Union Catalogue continues to shrink", and they base themselves on a comparison between the growth of the national union catalogue and that of the holdings of Canadian libraries as reported in the D.B.S. Survey of Libraries. This survey covers public libraries, libraries in universities, colleges and other post-secondary educational institutions and in centralized schools, as well as government and special libraries; all told, some 4,300 libraries with collective holdings of some 46,000,000 volumes in 1965. Based on such comparisons, it is obvious that the decline in coverage of the national union catalogue is now more rapid than before and that, as time goes, it will include an increasingly smaller percentage of the total holdings of Canadian libraries. But that is not the problem. Any national union catalogue anywhere in the world covers a gradually decreasing portion of the total library holdings of the country. And this is as it should be. The larger the number of libraries, the larger the duplication of volumes which need not be reported to a national union catalogue.

The cost of having all libraries report to any national union catalogue would be staggering; such an operation would be unmanageable, and indeed useless. Now, the comparison as made in the Macdonald Report is even more misleading inasmuch as the number of volumes reported by D.B.S. includes serials, periodicals and government documents which, in a great many libraries, are not catalogued and not reported to the national union catalogue, which make the comparison even less meaningful than could appear at first sight to the layman. Holdings of periodicals in the humanities and the social sciences currently received by 179 libraries are reported in the two-volume Union List of Periodicals with which librarians are familiar but which is not mentioned in the Macdonald Report although it represents millions of volumes included in the D.B.S. Survey. Furthermore, the Macdonald Report says: "Some libraries carry out their commitments faithfully, while others - including some of the most important - report pitifully when they report at all." Well, this is simply not true. We do check their reporting periodically, and all important libraries but one do report their accessions to the national union catalogue. Those who do not are small special libraries, the holdings of which represent a very small percentage of the total files.

The best way to evaluate the usefulness of the national union catalogue is not to relate its coverage to the total library holdings of the country, but to assess its efficiency in locating titles and in communicating these locations to inquirers. In other words, the service provided by the national union catalogue should be judged by the quality of its performance; the extent of the service now provided by the National Union Catalogue was reported in paragraph 9 above. In spite of its deficiencies, the National Union Catalogue does render invaluable services to research workers from coast to coast. A great deal of work remains to be done before we can proceed with plans to

have it automated or printed, and we cannot be but happy to see that the Macdonald Report recommends such programmes; we would have been happier if it had recognized its present merits along with some of its weaknesses. It would be unwise, however, to predicate the automation of the national union catalogue upon the highly hypothetical development and application of uniform rules in most libraries as suggested by the Macdonald Report and we will move ahead, regardless of the degree of uniformity achieved. It would appear that the Macdonald Report also failed to see the international dimensions of the problem; any efforts we may make towards achieving in Canada a larger measure of uniformity in cataloguing would be affected, and in no small measure, by the degree of compatibility that will be achieved eventually among national bibliographies and other foreign catalogues stored in digital form in a central data bank. We are aware of the magnitude and complexity of the problems involved. We recognize that the recommendations of the authors of the Macdonald Report are basically sound; I must admit, however, that I am less optimistic than they appear to be about the feasibility of the ideal plan they propose.

36. With respect to the National Union Catalogue, the Downs Report recommended that efforts to decentralize it should be resisted. Referring to the proposed bibliographic Centre of the university libraries of Ontario, Downs stated: "One proposal is the creation at the Centre of a union catalogue in machine-readable form of the holdings of the Ontario university libraries, primarily for acquisitions, to serve as a guide to collection development. There is scarcely any question about the usefulness of such an instrument. A thorough re-examination of the plan is recommended, however, for the following reasons: (1) though in a different form, the information would be largely, if not entirely, duplicated in the National Union Catalogue; (2) the creation of a machine-readable union catalogue should be

a national, not a provincial, responsibility, to serve all of Canada and comprehensive of the country's research collections; furthermore, the logical location is at Ottawa in the National Library; (3) the establishment and maintenance of such a catalogue would constitute a heavy burden of expense on a single province.

"It has been the American experience that it is more efficient and economical to concentrate union catalogue information for the entire United States in the National Union Catalog at the Library of Congress, instead of attempting to operate local, state, or regional union catalogues. A complete record of research-type material held by libraries throughout Canada in the Union Catalogue at Ottawa, accompanied by the most modern communication devices, would undoubtedly be of the greatest service to scholars, students, and other library users. The goal should be to perfect the present Union Catalogue, not to duplicate or to replace it."

37. The high cost of cataloguing is also a matter of concern to library administrators. The availability of bibliographic data, both Canadian and foreign, in a central data bank in the National Library with which other libraries could be on-line could help in reducing cataloguing costs. Cooperative processing will be explored too by our Automation Study Team, as well as Canadian participation in the international programme now promoted by the Library of Congress, which is likely to develop into a world-wide system of shared-cataloguing. Mr. Edmond L. Applebaum, who coordinates the Library of Congress National Programme for Acquisitions and Cataloguing (which is the most ambitious programme ever undertaken to collect and catalogue the literature of the world) will come to Ottawa later this year to review with us our participation in NPAC.

38. With a view to making it easier for the National Library to adjust to new conditions, to meet new challenges and to play a leading role in the coordination of library

resources and services, a new National Library Act was drafted and recently adopted by Parliament. Bill C-171 (Appendix C) was fully discussed in both houses, and in their committees, and there is no need to discuss it again in this brief. Suffice it to call the attention of your committee to sections 7 and 8, which are the key sections of the new Act:

> 7. (1) Subject to the direction of the Minister, the National Librarian shall generally manage and direct the Library in such a manner that the facilities of the Library may be made available to the Government and people of Canada to the greatest extent consistent with the sound administration of the Library, and to that end may
> (a) undertake the collection, by purchase or otherwise, of books for the library;
> (b) compile and maintain a national union catalogue in which the contents of the principal library collections throughout Canada may be listed;
> (c) compile and publish a national bibliography in which books produced in Canada, written or prepared by Canadians or of special interest or significance to Canada may be noted and described;
> (d) lend, sell or otherwise dispose of books forming part of the Library; and
> (e) enter into book exchange agreements with libraries and other institutions in or outside Canada.
>
> (2) Subject to the direction of the Governor in Council, the National Librarian may coordinate the library services of departments, branches and agencies of the Government of Canada including
> (a) the acquisition and cataloguing of books;
> (b) the supply of professional advice, supervision and personnel; and
> (c) the provision of modern information storage and retrieval services including photocopying and microfilming services, electronic and other automated data processing services and facsimile or other communication of information services.
>
> 8. The National Librarian may, on terms and conditions approved by the Minister, enter into agreements with libraries and library and educational associations and institutions in and outside Canada in respect of library services, including library services referred to in subsection (2) of section 7.

39. To sum up, except for such national services as those provided by the National Library - the national bibliography,

the listing and microfilming of theses, the National Union Catalogue, the Union List of Periodicals in the Social Sciences and Humanities, the redistribution of duplicate material and the general reference service - little has been accomplished as yet in Canada, on a national basis, in the two vital areas of (a) rationalization of acquisitions, and (b) coordination of systems. Many surveys were completed in recent years, which go a long way in identifying problems more clearly, and in offering solutions. These receive our full attention. I expect to be in a position to submit next year to the Canadian government, and to other libraries, a plan for the development in the National Library of an integrated information system inter-related with those of other research libraries both at home and abroad. It is not possible for me to be more specific at this time for two main reasons: (a) the automation study is not completed, and (b) the budget is fixed by the government and voted by Parliament. What is obvious, though, is that the National Library must have at its disposal much greater human and financial resources if it is to carry out its mission effectively in the years ahead. (Appendix D) To quote B. W. Adkinson again: "Any plans that involve library automation had better show careful consideration of the possibilities and implications of connecting any one computer-based, record-keeping system with others that are engaged in parallel efforts . This is the more true as plans for national systems with emphasis on automation emerge. Any one system proposal that ignores the problem of ultimately looking into ultimate national configurations may be looked at as potentially schismatic." (op. cit.) This identifies a definite National Library responsibility.

40. The National Library Act provides also that the Library facilities "be made available to the Government and people of Canada". The new National Library Act provides also for a greater coordination of government libraries. The general

services of the National Library are obviously available to departmental libraries, as they are to other libraries in Canada. There is, however, as real a need of better coordinating the collections and services of libraries at the government level as at the national level, with a view to eliminating any unnecessary duplication of efforts and to maximizing the interchange of information. The survey of their resources (Appendix B) should be brought up-to-date; a survey of their services and systems should be initiated, too, as a prerequisite to any cooperative scheme that could be devised under section 7 (2) of the new Act.

41. With a view to keeping librarians, and other interested persons, better informed of significant activities and developments at the National Library, we began publishing this year a quarterly news bulletin, National Library News. It is free to libraries, on request. We hope that it will improve communications between the National Library and other libraries.

III - RECOMMENDATIONS

The Committee will appreciate that the following recommendations are those which, subject to review when the Automation Study now under way in the National Library is completed, the National Librarian intends to make to the proper government authorities in the coming years and that their implementation is conditional on the staff and finances available.

(a) Recommendations related to present services

1. That the national bibliography be improved by
   a) increasing its coverage by including additional categories of library matter, such as phonorecords, audio-visual educational kits, etc.;
   b) extending the subject treatment by ascribing subject headings in both English and French to all classes of entries;
   c) adding standard book numbers as their use becomes widespread in Canada;
   d) publishing it weekly rather than monthly, with monthly, quarterly and yearly cumulations;
   e) computerizing the publication of the whole text, which would make it practical to print-out for sale cards, subject bibliographies, provincial or regional lists, etc.
2. That the National Union Catalogue be improved by
   a) increasing its coverage by adding gradually other Canadian libraries with holdings useful for research;
   b) consolidating and editing fully present and future entries;
   c) computerizing the entire file in order to make it possible for libraries on-line (1) to have direct access to bibliographic data in machine-readable form and (2) to obtain on tape or in print the catalogue of their own holdings;

to print-out eventually the complete bibliography of all Canadian books and pamphlets, with their locations;

d) promoting the acceptance by participating libraries of a common format, preferably MARC II.

3. That the abbreviated Union List of Periodicals in the Social Sciences and Humanities held by Canadian Libraries published in 1967, and now out-of-print, be improved by

a) increasing its coverage by inviting more libraries to report their holdings of both dead and current periodicals;

b) computerizing its compilation and publication in order to produce up-dated complete or partial lists as required, which would expedite inter-library loans or telefacsimile transmission of information.

4. That a Union List of Canadian Newspapers held by Canadian Libraries, now being compiled, be similarly produced.

5. That the Union List of Non-Canadian Newspapers, published in 1968, be up-dated and new editions published from time to time.

6. That Canadian Theses be improved by

a) inviting periodically more universities to participate;

b) listing research in progress;

c) automating its compilation;

d) adding as a supplement, or as a companion inventory, a list of other categories of research in progress.

7. That the Canadian Theses on Microfilm Service be improved by making xerox and microfiche, as well as microfilm, copies available.

8. That funds be provided to publish at an early date Canadiana, 1867-1900, the complete bibliography of the period, listing more than 25,000 titles, the compilation of which is now

virtually completed; and to compile and publish eventually similar lists covering the period 1900-1950.

9. That the book budget of the National Library be considerably increased in order to develop a collection commensurate with Canada's needs, supplementing holdings of research and government libraries, especially by the acquisition of little-used material.

10. That the National Library negotiate and implement agreements for the exchange of publications with foreign countries, especially those with which Canada has close relations and which produce documents required for research.

11. That the Office of Library Resources be strengthened in order to complete at an early date the national inventory of research collections, to keep it up to date and disseminate its findings to interested libraries.

12. That the use of counterpart funds to acquire books from countries other than India, with which such an agreement now exists, be investigated.

13. That the legal deposit of books be extended to additional categories of library matter, such as phonorecords and newspapers, and that the required staff and space be available for that purpose.

14. That more staff and finances be provided with a view to eliminating within the next few years the large backlog of unprocessed material and to making it available for research.

15. That more staff be provided in order to expedite the listing of duplicate material and to make it available to other libraries.

(b) Recommendations related to new services

16. That an Office of Library Systems be established in the National Library with a view to

a) reviewing and implementing the system now being designed by the Study Team;

b) planning future developments;

c) collecting and disseminating information about library automation programmes.

17. That an inter-departmental committee on libraries be established to advise the National Librarian on the coordination of government libraries collections and services; and that the first initiative of such a committee be to advise on the nature and scope of a survey of such collections and services.

18. That a central newspaper indexing office for all government departments and agencies be established in the National Library, where news items would be kept permanently and coded for instantaneous retrieval and communication.

19. That the practicality of a national cooperative cataloguing scheme be fully investigated, involving private as well as government libraries.

20. That the National Library open an office in Washington, D.C., to have direct and constant access to information related to current library developments.

21. That funds be provided for the exchange of personnel with other large libraries, both in Canada and abroad.

22. That funds be provided for the payment of refresher courses for professional librarians.

23. That the National Library investigate the possibility of establishing, in cooperation with other libraries, indexing and abstracting services in fields in which such services are not now available, or are grossly inadequate.

24. That the National Library initiate and implement, in cooperation with other libraries, a programme for the preservation of brittle books through microfilming, de-acidification and lamination.

25. That the Government of Canada make plans without delay for erecting a separate building to house the Public Archives, preferably on the site immediately adjoining ours on the North-East side of Wellington Street; such a new building

to be completed not later than 1976 or 1977; and that a satellite warehouse be provided, when needed, to store little-used material.

(c) Other recommendations

26. That the provincial authorities establish central agencies for the listing and distribution of provincial documents.

27. That the Queen's Printer initiate a programme to reprint out of print government documents required for research and that microfilm, microfiche or xerox copies be made available.

28. That the Copyright Act be amended to make it legal for libraries to

a) make microfilm copies of copyrighted material for the sake of conservation;

b) photocopy missing pages in a book or a periodical, as well as a whole issue of a periodical if it is irreplaceable;

c) supply readers with copies of articles or of a reasonable portion of a book, provided it is for personal use and made in a single copy;

d) communicate copyrighted material to other libraries by telephotography.

29. That the Department of Communications ensure that the needs of the federal and other research libraries be met in any national and international communications systems which it may develop.

CHAPTER 330.

An Act respecting the Establishment of a National Library.

SHORT TITLE.

1. This Act may be cited as the *National Library Act*. Short title.

INTERPRETATION.

2. In this Act, Definitions.

(a) "Minister" means such member of the Queen's Privy Council for Canada as is named for the purpose by the Governor in Council; "Minister."

(b) "book" includes library matter of every kind, nature and description; and "Book."

(c) "published in Canada" means released in Canada for public distribution or sale, otherwise than by Her Majesty in right of a province, any agent or servant of Her Majesty in right of a province or any municipality. "Published in Canada."

3. A National Library is hereby established, consisting of all books placed in the care and custody of the National Librarian or delivered to or otherwise acquired by the National Librarian in accordance with this Act. Establishment of National Library.

4. The Governor in Council may appoint a person to be called the National Librarian, who shall be the custodian of the National Library having the control and management of the National Library in accordance with this Act. National Librarian.

5. The Governor in Council may appoint a person to be called the Assistant National Librarian, who shall assist the National Librarian in the performance of his duties under this Act, and shall act as National Librarian in the event of the absence or incapacity of the National Librarian. Assistant National Librarian.

6. The National Librarian and the Assistant National Librarian shall hold office during pleasure, and shall be paid such salaries as the Governor in Council determines. Tenure of office, salary

Library staff.

7. Such other officers, clerks and employees as are necessary for the proper control and management of the National Library may be appointed in accordance with the provisions of the *Civil Service Act*.

Establishment of Advisory Council.

8. (1) The Governor in Council may establish an Advisory Council, to advise and assist the National Librarian in connection with the organization and development of the National Library.

Membership.

(2) The membership of the Advisory Council shall consist of the following persons:

(a) the National Librarian, who shall be the Chairman;

(b) the General Librarian and the Parliamentary Librarian, who shall be members *ex officio;* and

(c) twelve other persons, at least one from each province, to be appointed by the Governor in Council for a term of four years, except that of those first appointed three shall be appointed for a term of one year each, three for a term of two years each and three for a term of three years each.

Eligibility for re-appointment.

(3) A person who, as a member of the Advisory Council, has served two consecutive terms of four years each is not eligible to be reappointed to the Council during the two years following the completion of his second term.

Expenses of members.

(4) Members of the Advisory Council shall not receive any remuneration, but are entitled to receive all reasonable travelling and living expenses incurred in the course of their duties as members of the Council.

Transfers of custody of books.

9. The Governor in Council may direct that any books in the care or custody of any department or agency of the Government or Parliament of Canada shall be transferred from such department or agency and placed in the care and custody of the National Librarian.

Powers and duties of Librarian.

10. Subject to the direction of the Minister, the National Librarian may

(a) undertake the collection, by purchase or otherwise, of books for the Library,

(b) compile and maintain a national union catalogue in which the contents of the principal library collections throughout Canada may be listed,

(c) compile and publish a national bibliography in which books produced in Canada, written or prepared by Canadians or of special interest or significance to Canada may be noted and described,

(d) lend, sell or otherwise dispose of books forming part of the Library, and enter into exchange agreements with libraries and other institutions both in Canada and elsewhere, and

(e) generally supervise and direct the work of the National Library in such a manner that the facilities of the Library may be made available to the Government and people of Canada to the greatest possible extent consistent with the sound administration of the Library.

11. (1) Subject to this section, the publisher of a book published in Canada shall, at his own expense and within one month from the date of publication, deliver two copies of the book to the National Librarian, who shall give to the publisher a written receipt therefor. **Deposit of books with Librarian.**

(2) The publisher of a book published in Canada who has complied with the requirements of section 52 of the *Copyright Act* is deemed to have complied with the requirements of this section. **Deemed to be compliance.**

(3) Where the retail value of the two copies required by subsection (1) to be delivered to the National Librarian exceeds in the aggregate twenty-five dollars, the publisher of the book is deemed to have complied with the requirements of this section if, at his own expense, he delivers to the National Librarian one copy only of the book, equal in quality to the best quality produced. **Value of copies.**

(4) The Minister may make regulations **Regulations.**

(a) respecting the quality of the copies required to be delivered to the National Librarian of any book the copies of which are not of uniform quality;

(b) prescribing generally the classes or kinds of books in respect of which only one copy is required to be delivered to the National Librarian; and

(c) prescribing the classes or kinds of books in respect of which no copies are required to be delivered to the National Librarian unless specially requested by him.

(5) Every publisher of a book published in Canada who contravenes any of the provisions of this section is guilty of an offence and is liable on summary conviction to a fine not exceeding twenty-five dollars. **Offence and penalty.**

12. (1) A special account in the Consolidated Revenue Fund is hereby established, called the National Library Purchase Account, to which shall be credited any money appropriated by Parliament in any fiscal year for the purpose of acquiring books for the National Library, and any **Purchase Account for acquisition of books.**

any expenditures made for that purpose in that or any subsequent fiscal year, including any costs in connection therewith, may be paid out of the money so appropriated and credited.

Special Operating Account.

(2) A special account in the Consolidated Revenue Fund is hereby established, called the National Library Special Operating Account, to which shall be credited all money received for the purpose of the National Library by way of donation, bequest or otherwise.

Amounts required.

(3) Any amounts required for the purposes of this Act may be paid out of the National Library Special Operating Account or out of any money appropriated by Parliament for such purposes.

Annual report.

13. The National Librarian shall within three months from the termination of each fiscal year submit to the Minister a report, in the form required by the Minister, of all proceedings under this Act for the fiscal year, and the Minister shall lay the report before Parliament within fifteen days after he receives it or, if Parliament is not then in session, within fifteen days after the commencement of the next ensuing session.

EDMOND CLOUTIER, C.M.G., O.A., D.S.P.
QUEEN'S PRINTER AND CONTROLLER OF STATIONERY
OTTAWA, 1952

20680—4

APPENDIX B

FEDERAL GOVERNMENT LIBRARIES IN OTTAWA

by

W. Kaye Lamb and Jack E. Brown

Reprinted from the Report of the National Librarian
for the fiscal year ending March 31, 1968

Ottawa 1968

APPENDIX III

FEDERAL GOVERNMENT LIBRARIES IN OTTAWA

Their Role in Canada's National Library System

This study of federal departmental libraries in Ottawa was undertaken to determine which of these libraries could, or should, form an integral link in Canada's national library system. The primary concern was therefore to assess each library's resources and ascertain the extent to which these resources either supplement or duplicate the collections held by the National Library and the National Science Library.

The survey revealed great variations in the manner in which these libraries are organized and administered, and in the quality of the service they provide. It was not within the terms of reference of the study to evaluate each library as regards operating efficiency, but the report does recommend the adoption of certain administrative practices and policies which would increase the effectiveness with which many of these libraries meet their responsibilities at either the departmental or national level.

From the point of view of resources, the federal libraries fall into three fairly distinct categories, which for convenience we shall call categories A, B, and C.

Category A Libraries

The category A libraries consist of or include substantial specialized collections of material that are not duplicated to any great degree either in the National Library or the National Science Library and which therefore supplement the two national libraries in an important way. There should be no need to duplicate in the national libraries items from these specialized collections, provided the material can be made readily available either on interlibrary loan or through photocopies. They should be considered therefore as forming part of the national library resources of the country. It is highly important, of course, that these collections should be adequately and systematically maintained and kept up to date, and the obligation to do this should be reflected in the budgets of the departments and agencies concerned.

One or two examples of these collections may be given by way of illustration. The library of the Geological Survey, consisting of about 100,000 volumes, is probably the most comprehensive collection of geological publications in Canada. This library has been developed to meet the needs of the Geological Survey and consequently reflects the changing interests of that

department. It is particularly rich in complete runs of geological journals and publications issued by government geology departments and geological societies throughout the world. Some duplication of publications covering such fields as paleontology, geochemistry, and mineralogy has occurred in the libraries of the Mines Branch, the National Museum and the National Science Library. This is logical and necessary to meet the day-to-day requirements of the departments served by these libraries. However, beyond this, it is surely unnecessary to duplicate the fine collections of the Geological Survey Library and it should be thought of as supplementing the National Science Library.

Similarly the library of the National Gallery of Canada, consisting of about 20,000 volumes and comprising a good working collection on Western art, and a collection on Canadian art that aims to be definitive, should be considered as being a supplement to the National Library that need not be duplicated there on a large scale.

Two special cases should be mentioned. The first is the main library of the Department of Agriculture. This consists of 350,000 volumes and is much the largest of the departmental libraries. For many years it has provided a nation-wide lending and reference service, and it has been suggested upon various occasions that it should be called the National Library of Agriculture. We feel, however, that it should rather be considered as being the senior library in the category A group, for very large segments of its collections have of necessity been duplicated in the National Science Library. The material that supplements the latter consists primarily of specifically agricultural publications, such as comprehensive files of agricultural experimental bulletins and kindred publications of many sorts.

The library of the Department of National Health and Welfare is the other special case. This library of 75,000 volumes includes substantial collections not available elsewhere, but much of this material must be kept available continuously in the department, ready for use by the staff at minimum notice. It cannot therefore be considered as being a national resource to the same degree as collections readily available on loan. Adequate copying equipment should solve this problem in part, but considerable duplication, either in the departmental library itself or elsewhere will also be necessary. As the National Science Library has been charged with the responsibility of building up a comprehensive collection in the fields of the medical and health sciences, the place for this duplication would appear to be there.

Other libraries that we feel fall within category A (though in one or two instances only by a narrow margin) include the libraries of the Dominion Bureau of Statistics, the Department of Labour, the Department of National Defence, the National Museum, the Public Archives and the Supreme Court.

Category B Libraries

At first sight many of the libraries we would place in category B do not seem to differ greatly from those in category A. From the point of view of the department or agency concerned there may in fact be little or no difference. Both categories consist of collections that serve departments or agencies and are essential for their operations. The only difference is that the category B libraries do not supplement the National Library or the National Science Library in any extensive way. All libraries include some books and serials not in either of the two national collections, but the volume of unduplicated material in the category B group is either not great or falls within narrow subject limits.

Two examples will suffice. The library of the Mines Branch, consisting of 85,000 volumes, is essential to the Branch. This library has been the victim of several departmental reorganizations and the continuity of some of its subject collections has suffered accordingly. With the exception of long runs of older files of periodicals and other publications dealing primarily with the technology of the mining industry, it is largely duplicated in the National Science Library. Similarly the library of the Department of Transport, with 60,000 volumes, is also largely duplicated at the National Science Library except for material relating to the economic and commercial aspects of transportation.

Category C Libraries

The category C libraries consist for the most part of working collections that are tools of a trade or profession rather than libraries in the usual sense. They include textbooks, manuals, handbooks and similar ready-reference material. These libraries are usually the centres from which current periodicals are distributed to interested staff members, and in which such back files as are preserved are kept. They are highly important for the people they serve, but they are of little importance to the national libraries as a source of material. On the other hand, we feel that an arrangement that would be very advantageous to these category C libraries could be worked out in co-operation with the National Library. Few of these so-called libraries warrant the full-time services of a professional librarian, yet all would benefit greatly from professional advice and supervision. Our hope is that the National Library will find it possible to add to its staff an Extension Librarian who will be available to help and advise departments and agencies with working collections of this kind. With this help, a good clerk should be able to operate them efficiently and satisfactorily.

Library Administration

Another opportunity for co-operation between many of the departmental libraries and the national libraries should be emphasized. In our view *the departmental collections should in most instances aim to be essentially*

working collections, with the emphasis on current materials. Few of them have day-to-day need for older material, including older serial and periodical files, and they would gain in space and in other ways if this material was deposited in the National Library or the National Science Library, whichever would be more appropriate. With the aid of Telex, Xerox and other means of rapid communication, this material would be recallable at short notice, and the national libraries would assume the task of making it available elsewhere, whenever the demand arose. There is far too great a tendency at present to judge a library and to determine the classification of its staff merely by its size, whereas a smaller collection, trimmed to essentials and to immediately useful material, would often be much more effective.

Continuity of policy and support is of prime importance to a library; from the point of view of the national libraries it is particularly important in the collections that supplement their own resources. Without it, good book collections can neither be assembled nor maintained. A number of circumstances – some inevitable but others avoidable – make continuity difficult to achieve for many of the government's libraries.

In any organization as vast as the Government of Canada changes are being made almost constantly, and these frequently affect libraries. The fairly recent complete reorganization of the old Departments of Citizenship and Immigration and of Northern Affairs and National Resources is one example; the creation of the new Department of Corporate and Consumer Affairs is another. Even changes in departmental accommodation can produce serious problems. At the moment, for example, the library of the National Museum is faced with the problem of serving an institution that is being housed in several widely separated locations. The moral would appear to be that *it is desirable to have book resources kept as compact and specialized as possible,* so that they can move with the unit of government they serve, should the necessity arise.

Lack of continuity can also result if the librarian in charge of a collection is not given adequate status and authority. At the moment there is wide variation in the hierarchial level of the library within departments and agencies. We feel that *it is essential that the librarian should be in close contact with officials at the policy-making level,* since it is here that the needs the library must meet will be determined. A chief librarian should report to an assistant deputy minister, or his equivalent in an agency. This is already the case in a few instances, but in a few only. We talked to one librarian of a 60,000-volume library who appeared to be at least five levels removed from the assistant deputy; in a still larger library we found that the library itself had no budget and the librarian had no authority to purchase books.

Several departments have established Library Committees for the avowed and highly desirable purpose of establishing library policies to meet departmental needs and to advise the librarian in the interpretation of these policies.

In only two instances did we find a committee actually performing this vital service – the result being efficient libraries providing essential services. Some of the committees had not met since their inception and existed in name only. Others met regularly but functioned as administrative rather than advisory bodies, allowing the librarian little opportunity to exercise judgment or initiative – the result being inadequate library resources and purely nominal service.

A librarian, who is presumably employed because of special skills and knowledge, *should have an adequate status and should have authority to act in accordance with a determined policy and within the limits of a distinct library budget.* Without this, continuity and intelligent planning are impossible. Without it, moreover, the government will find it increasingly difficult (as it is already finding it difficult) to fill senior positions in departmental and agency libraries. The type of person required for these positions will prefer to take employment elsewhere.

If these policies were followed, we are convinced that the effectiveness and efficiency of most of the departmental libraries would be increased substantially, both in relation to the departments it is their immediate purpose to serve, and to the national collections that many of them supplement in an important way.

W. Kaye Lamb,
National Librarian,
National Library.

Jack E. Brown,
Chief Librarian,
National Science Library.

May 21, 1968.

APPENDIX C

C-171

First Session, Twenty-Eighth Parliament,
17-18 Elizabeth II, 1968-69

THE HOUSE OF COMMONS OF CANADA

BILL C-171

An Act respecting the National Library

AS PASSED BY THE HOUSE OF COMMONS,
31st MARCH, 1969

C-171

Première Session, Vingt-huitième Législature,
17-18 Elizabeth II, 1968-69

CHAMBRE DES COMMUNES DU CANADA

BILL C-171

Loi concernant la Bibliothèque nationale

ADOPTÉ PAR LA CHAMBRE DES COMMUNES
LE 31 MARS 1969

The Queen's Printer, OTTAWA, 1969

28532

L'Imprimeur de la Reine, OTTAWA, 1969

1st Session, 28th Parliament, 17-18 Elizabeth II, 1968-69

THE HOUSE OF COMMONS OF CANADA

BILL C-171

An Act respecting the National Library

Her Majesty, by and with the advice and consent of the Senate and House of Commons of Canada, enacts as follows:

SHORT TITLE

Short Title

1. This Act may be cited as the *National Library Act*.

INTERPRETATION

Definitions

2. In this Act,

"Board"

(*a*) "Board" means the National Library Advisory Board established pursuant to section 9;

"Book"

(*b*) "book" means library matter of every kind, nature and description and includes any document, paper, record, tape or other thing published by a publisher, on or in which information is written, recorded, stored or reproduced;

"Library"

(*c*) "Library" means the National Library;

"Minister"

(*d*) "Minister" means the Secretary of State of Canada; and

"Published in Canada"

(*e*) "published in Canada" means released in Canada for public distribution or sale, otherwise than by Her Majesty in right of a province or by a municipality.

National Library continued

3. (1) The National Library established under section 3 of the Act referred to in section 16 is hereby continued.

1re Session, 28e Législature, 17-18 Elizabeth II 1968-69

CHAMBRE DES COMMUNES DU CANADA

BILL C-171

Loi concernant la Bibliothèque nationale

Sa Majesté, sur l'avis et du consentement du Sénat et de la Chambre des communes du Canada, décrète:

TITRE ABRÉGÉ

Titre abrégé

1. La présente loi peut être citée sous le titre: *Loi sur la Bibliothèque nationale.*

INTERPRÉTATION

Définitions

2. Dans la présente loi,

«Conseil»

a) «Conseil» désigne le Conseil consultatif de la Bibliothèque nationale créé en conformité de l'article 9;

«livre»

b) «livre» désigne les articles de bibliothèque de toute sorte, de toute nature et de toute désignation et s'entend également de tout document, tout écrit, tout disque, toute bande magnétique ou autre chose, publiés par un éditeur, où sont écrits, enregistrés, conservés ou reproduits des informations;

«Bibliothèque»

c) «Bibliothèque» désigne la Bibliothèque nationale;

«Ministre»

d) «Ministre» désigne le Secrétaire d'État du Canada; et

«publié au Canada»

e) «publié au Canada» signifie mis en circulation au Canada en vue d'une distribution ou d'une vente publiques, autrement que par Sa Majesté du chef d'une province ou par une municipalité.

Maintien de la Bibliothèque nationale

3. (1) La Bibliothèque nationale créée en vertu de l'article 3 de la loi mentionnée à l'article 16 est par la présente maintenue.

Books

(2) Every book placed in the care and custody of the National Librarian or delivered to or otherwise acquired by the National Librarian pursuant to this Act, otherwise than by loan, is vested in Her Majesty and forms part of the Library.

ADMINISTRATION OF LIBRARY

Minister

4. The Minister shall preside over and has the supervision of the management and direction of the Library.

National Librarian

5. (1) The Governor in Council may appoint an officer to be called the National Librarian.

Idem

(2) The National Librarian has the rank and status of a deputy head of a department and, subject to section 4, has the management and direction of the Library.

Tenure and Salary

(3) The National Librarian holds office during pleasure and shall be paid such salary as is fixed by the Governor in Council.

Associate National Librarian

6. (1) The Governor in Council may appoint an officer to be called the Associate National Librarian.

Idem

(2) The Associate National Librarian shall assist the National Librarian in the performance of his duties under this Act and shall act as National Librarian in the event of the absence or incapacity of the National Librarian or if the office of National Librarian is vacant.

Tenure and salary

(3) The Associate National Librarian holds office during pleasure and shall be paid such salary as is fixed by the Governor in Council.

Livres

(2) Tout livre confié aux soins et à la garde du directeur général de la Bibliothèque nationale ou qui lui est livré ou est d'une autre façon acquis par lui en conformité de la présente loi, autrement qu'à titre de prêt, appartient à Sa Majesté et fait partie de la Bibliothèque.

ADMINISTRATION DE LA BIBLIOTHÈQUE

Ministre

4. Le Ministre préside à la gestion et à la direction de la Bibliothèque et en a la surveillance.

Directeur général de la Bibliothèque nationale

5. (1) Le gouverneur en conseil peut nommer un fonctionnaire à titre de directeur général de la Bibliothèque nationale.

Idem

(2) Le directeur général de la Bibliothèque nationale a rang de sous-ministre et, sous réserve des dispositions de l'article 4, il gère et dirige la Bibliothèque.

Mandat et traitement

(3) Le directeur général de la Bibliothèque nationale est nommé à titre amovible et perçoit le traitement que fixe le gouverneur en conseil.

Directeur général adjoint de la Bibliothèque nationale

6. (1) Le gouverneur en conseil peut nommer un fonctionnaire à titre de directeur général adjoint.

Idem

(2) Le directeur général adjoint de la Bibliothèque nationale seconde le directeur général dans l'exercice des fonctions qui lui incombent en vertu de la présente loi. Il fait fonction de directeur général de la Bibliothèque nationale en cas d'absence ou d'incapacité de ce dernier ou en cas de vacance du poste de directeur général.

Mandat et traitement

(3) Le directeur général adjoint est nommé à titre amovible et perçoit le traitement que fixe le gouverneur en conseil.

POWERS AND DUTIES OF NATIONAL LIBRARIAN

Powers and duties of Librarian

7. (1) Subject to the direction of the Minister, the National Librarian shall generally manage and direct the Library in such a manner that the facilities of the Library may be made available to the Government and people of Canada to the greatest extent consistent with the sound administration of the Library, and to that end may

(*a*) undertake the collection, by purchase or otherwise, of books for the library;

(*b*) compile and maintain a national union catalogue in which the contents of the principal library collections throughout Canada may be listed;

(*c*) compile and publish a national bibliography in which books produced in Canada, written or prepared by Canadians or of special interest or significance to Canada may be noted and described;

(*d*) lend, sell or otherwise dispose of books forming part of the Library; and

(*e*) enter into book exchange agreements with libraries and other institutions in or outside Canada.

Coordination of certain library services

(2) Subject to the direction of the Governor in Council, the National Librarian may coordinate the library services of departments, branches and agencies of the Government of Canada including

(*a*) the acquisition and cataloguing of books;

(*b*) the supply of professional advice, supervision and personnel; and

(*c*) the provision of modern information storage and retrieval services including photocopying and microfilming services, electronic and other automated data processing services and facsimile or other communication of information services.

ATTRIBUTIONS DU DIRECTEUR GÉNÉRAL DE LA BIBLIOTHÈQUE NATIONALE

Attributions du directeur général

7. (1) Sous réserve des instructions du Ministre, le directeur général de la Bibliothèque nationale gère et dirige la Bibliothèque de façon à la mettre à la disposition du gouvernement et de la population du Canada dans la plus large mesure compatible avec sa bonne administration et peut, à cette fin,

a) collectionner, par acquisition à titre onéreux ou gratuit, des livres pour la Bibliothèque;

b) compiler et tenir un catalogue collectif national dans lequel peut être inscrit le contenu des principales collections de bibliothèques du Canada;

c) compiler et publier une bibliographie nationale dans laquelle peuvent être notés et décrits les livres produits au Canada, écrits et préparés par des Canadiens ou présentant un intérêt spécial ou une importance particulière pour le Canada;

d) prêter ou vendre des livres de la Bibliothèque ou autrement en disposer; et

e) conclure avec des bibliothèques et autres institutions du Canada ou d'ailleurs des accords pour l'échange de livres.

Coordination de certains services de bibliothèque

(2) Sous réserve des instructions du gouverneur en conseil, le directeur général de la Bibliothèque nationale peut coordonner les services de bibliothèque des ministères, départements, directions ou organismes du gouvernement du Canada, notamment

a) l'acquisition et le catalogage des livres;

b) la fourniture de conseils techniques, de surveillants et de personnel; et

c) la fourniture de services modernes de conservation et de recouvrement des informations, notamment les services de photocopie et de microfilmage ainsi que les services électroniques et autres services automatisés de traitement des informations et les services de communication des informations par fac-similé ou autrement.

Agreements respecting library services

8. The National Librarian may, on terms and conditions approved by the Minister, enter into agreements with libraries and library and educational associations and institutions in and outside Canada in respect of library services, including library services referred to in subsection (2) of section 7.

Accords concernant des services de bibliothèque

8. Le directeur général de la Bibliothèque nationale peut, selon les modalités approuvées par le Ministre, conclure, avec des bibliothèques et des associations et institutions s'occupant de bibliothèques et d'éducation au Canada et ailleurs, des accords portant sur les services de bibliothèque, notamment les services mentionnés au paragraphe (2) de l'article 7.

NATIONAL LIBRARY ADVISORY BOARD

CONSEIL CONSULTATIF DE LA BIBLIOTHÈQUE NATIONALE

National Library Advisory Board

9. (1) The Governor in Council may establish a Board, to be known as the National Library Advisory Board, to advise and assist the National Librarian in the organization and development of the Library and to advise and assist in the development of the relations of the Library with other libraries and library and educational associations and institutions.

Conseil consultatif de la Bibliothèque nationale

9. (1) Le gouverneur en conseil peut créer un Conseil, appelé Conseil consultatif de la Bibliothèque nationale, chargé d'une part de conseiller et d'aider le directeur général de la Bibliothèque nationale à organiser et développer la Bibliothèque et de contribuer d'autre part, par ses conseils et son aide, à développer les rapports de la Bibliothèque avec d'autres bibliothèques et avec des associations et institutions s'occupant de bibliothèques et d'éducation.

Membership of Board

(2) The membership of the Board shall consist of

(*a*) the National Librarian;

(*b*) the Parliamentary Librarian, the Dominion Archivist and the Librarian of the National Science Library of the National Research Council of Canada, who shall be members *ex officio;*

(*c*) two other persons, one each representing and nominated by the Canada Council and the Association of Universities and Colleges of Canada; and

(*d*) nine other persons, at least four of whom shall be professional librarians and each of whom shall be appointed by the Governor in Council to hold office for a term of not more than four years.

Composition du Conseil

(2) Le Conseil se compose

a) du directeur général de la Bibliothèque nationale;

b) du bibliothécaire parlementaire, de l'archiviste fédéral et du bibliothécaire de la Bibliothèque scientifique nationale du Conseil national de recherches du Canada, qui sont membres de droit;

c) de deux autres personnes représentant respectivement le Conseil des Arts du Canada et l'Association des universités et collèges du Canada et respectivement désignées par ces organismes; et

d) de neuf autres personnes dont quatre au moins sont des bibliothécaires diplômés et qui sont toutes nommées par le gouverneur en conseil pour un mandat de quatre ans au maximum.

(3) The Board may, with the approval of the Governor in Council, elect one of its members to be Chairman of the Board.

(3) Le Conseil peut, avec l'approbation du gouverneur en conseil, élire un de ses membres à la présidence du Conseil.

Eligibility for re-appointment

(4) A person appointed pursuant to paragraph (*d*) of subsection (2) who has served as a member of the Board for two consecutive terms is not, during the twelve months following the completion of his second term, eligible for reappointment.

Condition à remplir pour pouvoir être nommé de nouveau

(4) Une personne nommée en conformité de l'alinéa *d*) du paragraphe (2) qui a rempli deux mandats consécutifs en qualité de membre du Conseil ne peut, pendant les douze mois qui suivent la fin de son second mandat, être renommée.

Remuneration

(5) Each member of the Board who is not an employee of Her Majesty, an agent of Her Majesty or the Canada Council shall be paid, for each day he attends any meeting of the Board or any committee of the Board, such remuneration therefor as may be approved by the Governor in Council.

Expenses

(6) Each member of the Board is entitled to be paid reasonable travelling and living expenses while absent from his ordinary place of residence in connection with the work of the Board.

Rules

(7) The Board may, with the approval of the Minister, make rules governing its procedure and the conduct of the work of the Board, including the establishment of committees of the Board.

Rémunération

(5) Tout membre du Conseil qui n'est pas employé de Sa Majesté, mandataire de Sa Majesté ou du Conseil des Arts du Canada perçoit, pour chaque jour au cours duquel il assiste à une réunion du Conseil ou d'un comité du Conseil, la rémunération y afférente que peut approuver le gouverneur en conseil.

Dépenses

(6) Tout membre du Conseil a le droit de percevoir des frais raisonnables de voyage et de subsistance lorsque les travaux du Conseil l'amènent à s'absenter de son lieu ordinaire de résidence.

Règles

(7) Le Conseil peut, avec l'approbation du Ministre, établir les règles qui gouvernent sa procédure et la conduite de ses travaux, notamment la création de ses comités.

TRANSFER OF BOOKS

Transfer of books

10. (1) The Governor in Council may direct that the books in the care or custody of any department, branch or agency of the Government of Canada be transferred from that department, branch or agency and placed in the care and custody of the National Librarian.

Surplus books

(2) Notwithstanding the *Surplus Crown Assets Act*, all books that have become surplus to the requirements of any department, branch or agency of the Government of Canada shall be placed in the care and custody of the National Librarian.

Application of *Surplus Crown Assets Act*

(3) The *Surplus Crown Assets Act* does not apply to any books placed in the care and custody of, delivered to or otherwise acquired by the National Librarian pursuant to this Act.

TRANSFERT DE LIVRES

Transfert de livres

10. (1) Le gouverneur en conseil peut ordonner que les livres confiés aux soins ou à la garde de quelque ministère, département, direction ou organisme du gouvernement du Canada soient transférés et confiés aux soins et à la garde du directeur général de la Bibliothèque nationale.

Surplus de livres

(2) Nonobstant la *Loi sur les biens de surplus de la Couronne*, tous les livres qui ne sont plus nécessaires à quelque ministère, département, direction ou organisme du gouvernement du Canada doivent être confiés aux soins et à la garde du directeur général de la Bibliothèque nationale.

Application de la *Loi sur les biens de surplus de la Couronne*

(3) La *Loi sur les biens de surplus de la Couronne* ne s'applique à aucun livre confié aux soins et à la garde du directeur général de la Bibliothèque nationale ou à lui livré ou par lui autrement acquis en conformité de la présente loi.

NEW PUBLICATIONS

Legal deposit of new books

11. (1) Subject to this section and the regulations, the publisher of a book published in Canada shall, at his own expense and within one week from the date of

NOUVELLES PUBLICATIONS

Dépôt légal de nouveaux livres

11. (1) Sous réserve du présent article et des règlements, l'éditeur d'un livre publié au Canada, doit, à ses propres frais et dans le délai d'une semaine à compter de

publication, send two copies of the book to the National Librarian, who shall give to the publisher a written receipt for the book.

la date de publication, envoyer deux exemplaires du livre au directeur général de la Bibliothèque nationale qui lui en donnera récépissé.

Value of copies

(2) Where the retail value of a book published in Canada exceeds fifty dollars, the publisher of the book is deemed to have complied with the requirements of this section if, at his own expense and within one week from the date of publication, he sends to the National Librarian one copy of the book, equal in quality to the best quality produced.

Valeur des exemplaires

(2) Lorsque la valeur au détail d'un livre publié au Canada excède cinquante dollars, l'éditeur du livre est censé s'être conformé aux exigences du présent article s'il envoie au directeur général de la Bibliothèque nationale, à ses propres frais et dans le délai d'une semaine à compter de la date de publication, un seul exemplaire du livre, pourvu que cet exemplaire soit de qualité égale à la meilleure qualité produite.

Regulations

(3) The Minister may make regulations

(a) respecting the quality of the copies required to be sent to the National Librarian of any book the copies of which are not of uniform quality;

(b) prescribing the classes or kinds of books in respect of which only one copy is required to be sent to the National Librarian; and

(c) prescribing the classes or kinds of books in respect of which no copies are required to be sent to the National Librarian unless specifically requested by him.

Règlements

(3) Le Ministre peut établir des règlements

a) concernant la qualité des exemplaires à envoyer au directeur général de la Bibliothèque nationale pour tout livre dont les exemplaires ne sont pas de qualité uniforme;

b) prescrivant les catégories ou genres de livres dont il suffit d'envoyer un seul exemplaire au directeur général de la Bibliothèque nationale; et

c) prescrivant les catégories ou genres de livres pour lesquels l'envoi d'exemplaires au directeur général de la Bibliothèque nationale n'est exigé qu'à la demande spéciale de ce dernier.

Offence and punishment

(4) Every publisher of a book published in Canada who contravenes or fails to comply with any provision of this section or the regulations is guilty of an offence and is liable on summary conviction to a fine not exceeding one hundred and fifty dollars.

Infractions et peines

(4) Tout éditeur d'un livre publié au Canada qui enfreint l'une quelconque des dispositions du présent article ou des règlements ou qui ne s'y conforme pas est coupable d'une infraction et passible, sur déclaration sommaire de culpabilité, d'une amende d'au plus cent cinquante dollars.

FINANCIAL

DISPOSITIONS FINANCIÈRES

Purchase Account

12. (1) There shall be credited to the special account in the Consolidated Revenue Fund, called the National Library Purchase Account, all amounts appropriated by Parliament in any fiscal year for the purpose of acquiring books for the Library.

Compte d'achat

12. (1) Le compte spécial du Fonds du revenu consolidé, appelé Compte d'achat de la Bibliothèque nationale, est crédité de toutes les sommes affectées par le Parlement, au cours d'une année financière quelconque, à l'acquisition de livres pour la Bibliothèque.

Expenditures for books

(2) Any amounts required for the purpose of acquiring books for the Library, including any costs in connection with such acquisitions, may be paid out of amounts credited to the National Library Purchase Account.

Special Operating Account

(3) There shall be credited to the special account in the Consolidated Revenue Fund, called the National Library Special Operating Account, all amounts received for the purpose of the Library by way of donation, bequest or otherwise.

Amounts required

(4) Subject to subsection (2), all amounts required for the purposes of this Act may be paid out of the National Library Special Operating Account or out of any moneys appropriated by Parliament therefor.

Annual Report

13. The National Librarian shall within three months after the end of each fiscal year submit to the Minister a report, in the form required by the Minister, of all proceedings under this Act for the fiscal year, and the Minister shall lay the report before Parliament within fifteen days after the receipt thereof or, if Parliament is not then sitting, on any of the first fifteen days next thereafter that Parliament is sitting.

TRANSITIONAL AND REPEAL

Librarian continued in office

14. The person who, immediately before the coming into force of this Act, held the office of National Librarian under the Act referred to in section 16 shall be deemed to have been appointed National Librarian under this Act.

Frais d'acquisition de livres

(2) Toutes sommes requises aux fins d'acquisition de livres pour la Bibliothèque, y compris les frais accessoires de l'acquisition, peuvent être payées sur les crédits du Compte d'achat de la Bibliothèque nationale.

Compte spécial d'exploitation

(3) Le compte spécial du Fonds du revenu consolidé, appelé Compte spécial d'exploitation de la Bibliothèque nationale, est crédité de toutes les sommes reçues, pour les fins de la Bibliothèque, sous forme de dons, de legs ou autrement.

Sommes requises

(4) Sous réserve du paragraphe (2), toutes les sommes requises aux fins de la présente loi peuvent être payées sur les crédits du Compte spécial d'exploitation de la Bibliothèque nationale ou sur les deniers affectés à cet effet par le Parlement.

Rapport annuel

13. Le directeur général de la Bibliothèque nationale doit, dans les trois mois qui suivent la fin de chaque année financière, soumettre au Ministre, en la forme prescrite par ce dernier, un rapport sur tout ce qui a été fait en vertu de la présente loi pendant l'année financière, et le Ministre doit déposer le rapport au Parlement dans les quinze jours qui suivent sa réception ou, si le Parlement ne siège pas à ce moment-là, l'un des quinze premiers jours où il siège par la suite.

DISPOSITIONS TRANSITOIRES ET ABROGATION

Le bibliothécaire national devient directeur général de la Bibliothèque nationale

14. La personne qui, immédiatement avant l'entrée en vigueur de la présente loi, occupait le poste de bibliothécaire national en vertu de la loi mentionnée à l'article 16 est censée avoir été nommée directeur général de la Bibliothèque nationale en vertu de la présente loi.

Repeal of R.S., c. 55, s. 52

15. Section 52 of the *Copyright Act* is repealed.

Repeal of R.S., c. 330

16. The *National Library Act*, chapter 330 of the Revised Statutes of 1952, is repealed.

COMMENCEMENT

Coming into force

17. This Act shall come into force on a day to be fixed by proclamation.

Abrogation de l'art. 52 du c. 55 des S.R.

15. L'article 52 de la *Loi sur le droit d'auteur* est abrogé.

Abrogation du c. 330 des S.R.

16. La *Loi sur la Bibliothèque nationale*, qui constitue le chapitre 330 des Statuts revisés de 1952, est abrogée.

DATE D'ENTRÉE EN VIGUEUR

Entrée en vigueur

17. La présente loi entrera en vigueur à une date qui sera fixée par proclamation.

APPENDIX D

ESTABLISHMENT AND BUDGET

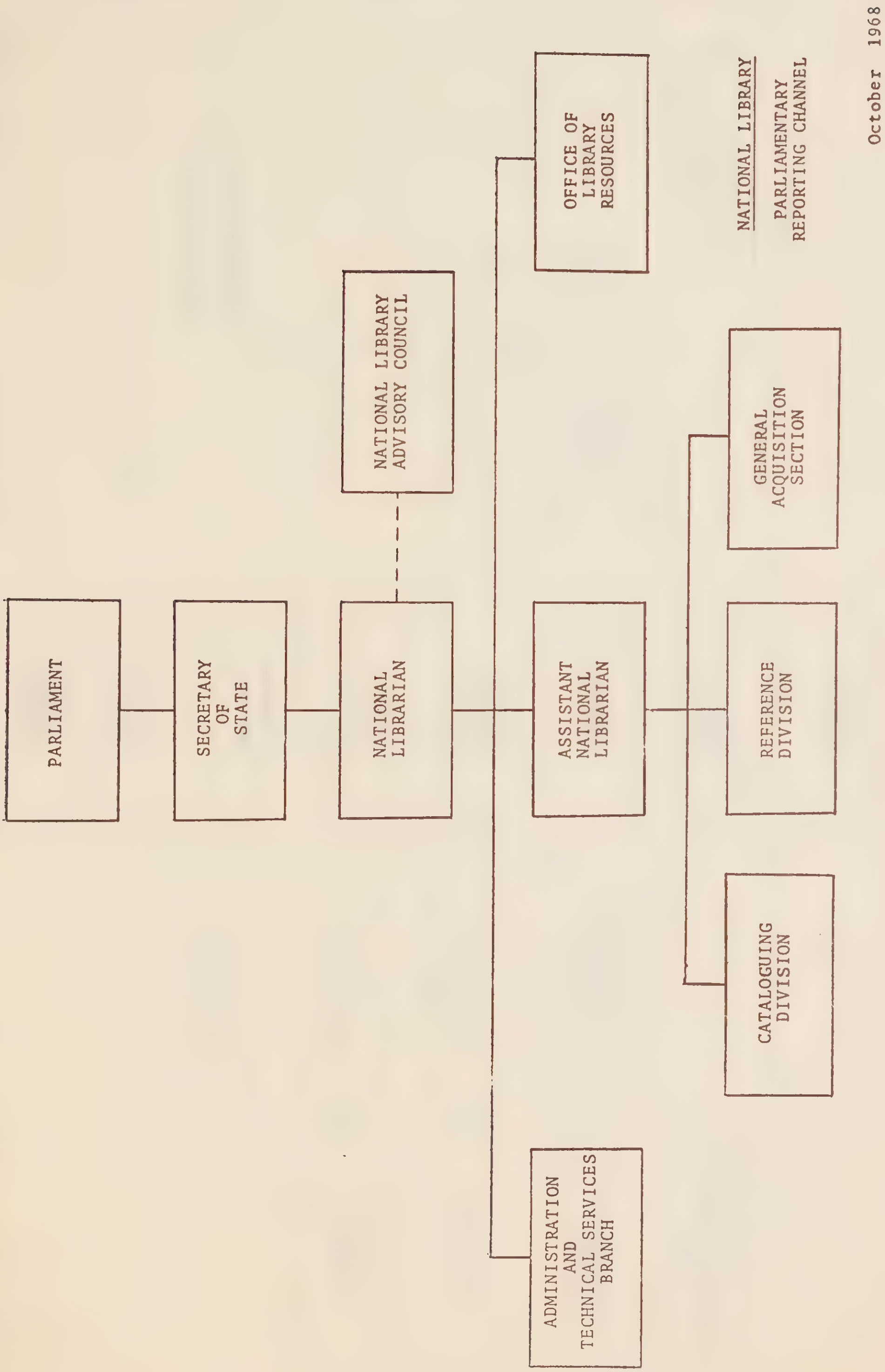
	NATIONAL LIBRARY		LIBRARY OF CONGRESS	
	Staff	Budget	Staff	Budget
1962/63	57	$ 351,300.00	3,085	$ 29,513,086.96
1963/64	57	360,140.00	3,226	31,193,783.53
1964/65	66	505,300.00	3,390	35,776,020.50
1965/66	121	709,000.00	3,412	38,953,593.15
1966/67	158	981,000.00	3,890	44,980,419.06
1967/68	210	1,620,000.00	4,205	53,094,695.00
1968/69	227	1,585,000.00		
1969/70	233	1,963,000.00		

APPENDIX D-1

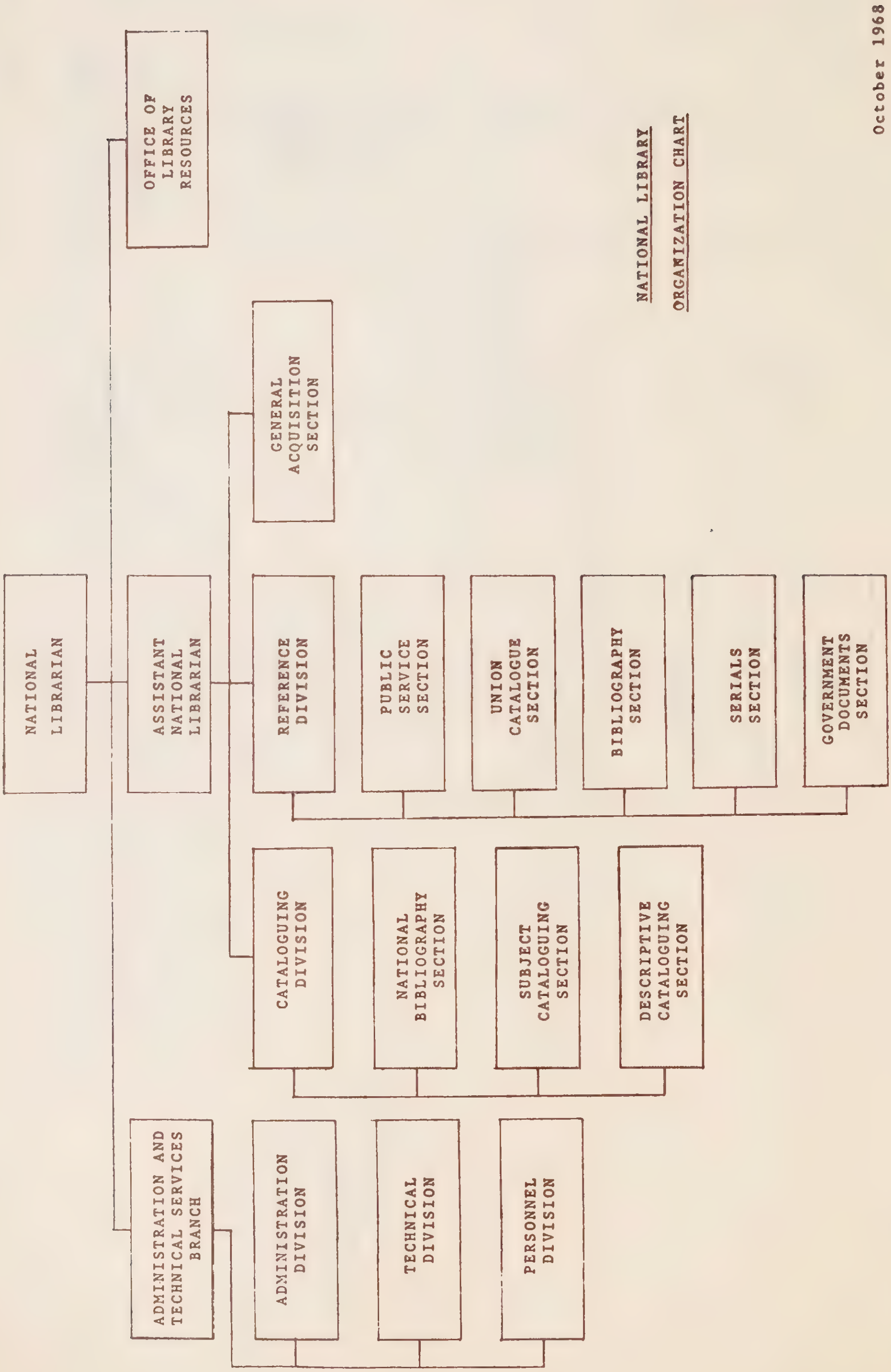
Budget of large Canadian Libraries, 1967-68

Library	Total Budget	Book Budget
University of Toronto	6,115,800	1,927,000
Toronto Public Library (1966)	3,475,000	518,375
University of British Columbia	3,264,386	1,318,761
University of Alberta	2,764,360	1,333,000
University of Western Ontario	2,200,000	1,000,000
McGill University	2,125,000	710,000
Université Laval	2,032,000	625,000
Vancouver Public Library (1966)	1,807,442	229,800
National Library of Canada	1,620,000	250,000
Bibliothèque municipale de Montréal (1966)	1,613,376	268,900
Université de Montréal	--	--
North York Public Library (1966)	1,500,000	320,000
University of Calgary	1,486,241	758,000
Simon Fraser University	1,429,528	624,000
York University	1,400,000	700,000
McMaster University	1,400,000	750,000
University of Victoria	1,340,000	600,000
Queen's University	1,250,000	412,400
Dalhousie University	1,200,000	600,000
University of Manitoba	1,166,083	427,000

APPENDIX D-2


NATIONAL LIBRARY
PARLIAMENTARY REPORTING CHANNEL
October 1968
PARLIAMENT
SECRETARY OF STATE
NATIONAL LIBRARIAN
NATIONAL LIBRARY ADVISORY COUNCIL
OFFICE OF LIBRARY RESOURCES
ASSISTANT NATIONAL LIBRARIAN
ADMINISTRATION AND TECHNICAL SERVICES BRANCH
GENERAL ACQUISITION SECTION
REFERENCE DIVISION
CATALOGUING DIVISION

APPENDIX D-3


NATIONAL LIBRARY
ORGANIZATION CHART
October 1968
NATIONAL LIBRARIAN
ASSISTANT NATIONAL LIBRARIAN
OFFICE OF LIBRARY RESOURCES
ADMINISTRATION AND TECHNICAL SERVICES BRANCH
GENERAL ACQUISITION SECTION
REFERENCE DIVISION
PUBLIC SERVICE SECTION
UNION CATALOGUE SECTION
BIBLIOGRAPHY SECTION
SERIALS SECTION
GOVERNMENT DOCUMENTS SECTION
CATALOGUING DIVISION
NATIONAL BIBLIOGRAPHY SECTION
SUBJECT CATALOGUING SECTION
DESCRIPTIVE CATALOGUING SECTION
ADMINISTRATION DIVISION
TECHNICAL DIVISION
PERSONNEL DIVISION

APPENDIX 189

B R I E F
TO THE
SENATE COMMITTEE ON SCIENCE POLICY

The Pharmacological Society of Canada
August 1969

Table of Contents

PART I. Introduction

1. The Pharmacological Society of Canada

The Pharmacological Society of Canada was established in 1958 and presently groups 222 scientists. The largest contingent of members is made up of staff members of Pharmacology Departments of Canadian medical schools; other members belong to various other laboratories in universities, the drug industry and the government. In addition, a small percentage are foreign members, mostly from the United States.

Membership in the Society may be granted to any person who has conducted research and published meritorious papers in pharmacology or has adequate experience in the teaching of this discipline.

The affairs of the Society are managed by a council consisting of the President, the Vice-President, the Secretary, the Treasurer and three additional council members and the immediate Past President. The council is responsible for the general management of the Society during intervals between meetings. The Society is represented on the Board of the Canadian Federation of Biological Societies and appoints delegates to various other societies or committees, such as the International Union for Pharmacology, the Biological Council of Canada and the Canadian Drug Safety Council.

The constitution of the Society states in broad terms that the object of the Society shall be to develop the science of Pharmacology. This is achieved mostly through the organization of an annual meeting. This meeting is held in conjunction with the meeting of the Canadian Federation of Biological Societies which includes six other scientific societies. The purpose of this annual meeting is to bring

the membership together to present scientific papers and to provide a medium for discussion of mutual interests. Since the members of six other biological societies meet at the same time, this affords valuable opportunities for exchange of ideas among scientists working in related disciplines.

2. The Scope of Modern Pharmacology

Modern pharmacology is a broad biological and medical science. It is the science of the action of drugs on living organisms. To most people, the word "drug" implies a substance that is introduced into the living body in order to prevent or fight disease. To the pharmacologist, the word "drug" is much broader and encompasses all chemical substances that produce an effect on living cells, tissues or whole organisms.

Pharmacology is also a multi-disciplinary science. It has developed its own set of principles and methods to study the mode of action of drugs; but it has also borrowed many of the techniques and approaches used in related sciences such as biochemistry and physiology. By providing new concepts and new drugs which may be used as tools by other researchers, pharmacology continues to be essential to many other related disciplines and grows in dynamic interchange with most other biomedical sciences.

Pharmacology can be divided into general and special pharmacology. General pharmacology is the branch dealing with the laws governing the actions of drugs, their distribution, metabolism and excretion. Special pharmacology deals with

specific classes of drugs acting on a particular organ or system of the body. One can therefore identify various sub-disciplines, for example, cardiovascular pharmacology and pharmacology of the kidney. A very important aspect of pharmacology, neuropharmacology, is concerned with the effects of drugs on motor, sensory and behavioral aspects of the nervous system. A subdivision of the latter, behavioral pharmacology or psychopharmacology, has grown rapidly during the last fifteen years, because of: 1) the discovery of potent substances that selectively modify the behavioral components of brain function and have proven themselves to be effective adjuncts in the treatment of many forms of disturbed behaviour, 2) a better social awareness of the seriousness of mental diseases and of the dangers of drug abuse, and 3) because of the possibility of studying more objectively the effects of drugs on behaviour. Psychopharmacological agents also have played a major role in curbing the rising morbidity from mental diseases and have greatly influenced the modern practice of psychiatry.

Another important branch of pharmacology, chemotherapy, is concerned with drugs used in the prevention or treatment of diseases which result from the invasion of the body by bacteria, virus, parasites, or tumor cells. The development of sulfa drugs and antibiotics, and their beneficial use in infectious diseases has been one of the significant events of the century. The dedicated quest for drugs to treat viral diseases and cancer is an important and difficult challange, which will be met successfully in future through the concerted efforts of pharmacologists and other biomedical scientists.

For many years, a tremendous gap existed between pharmacology and drug therapeutics. Drugs studied in animals were often

tested and used extensively in man without satisfactory knowledge of their properties in the human species. Many useful biological properties of chemical substances were discovered in humans not through logic, but by chance. Likewise, serious toxic effects were discovered in humans only after usage of the drug. The thalidomide tragedy is one example. Unfortunately, the testing of new drugs in animals cannot yield all the information needed for always carrying such drugs safely into human medicine. The science of clinical pharmacology has partially bridged this gap. This relatively young discipline deals with the objective evaluation of the effects of drugs in man under the best controlled experimental conditions. Clinical pharmacology usually encompasses but is sometimes dissociated from human pharmacology, which is the study of the effects of drugs in normal human volunteers, a most important step before using drugs in volunteer diseased patients. Because of the legal and moral implications of testing the effects of chemicals in human beings, the practive of clinical pharmacology is fraught with many difficulties; but its contribution in recent years has been noteworthy and its future looks most promising.

Another important part of pharmacology, or very closely related discipline, is toxicology, the science of poisons. It deals with the effects of drugs administered in high dosage, and also with industrial and household poisons, toxic gases, and radioactive agents. The important problems of water and air pollution also fall within the scope of toxicology.

The impact of pharmacology on modern medicine is considerable. Drugs can produce effective cures and a beneficial relief of many diseases, but drugs themselves may also induce disease states. For example, when an antibiotic is given by mouth to treat a systemic infection it may alter the bacterial flora of the intestine to such a degree that microorganisms which were previously innocuous then become pathogenic and give rise to superimposed infections. Many highly beneficial drugs will produce, in small numbers of cases, deleterious effects on the organs responsible for manufacturing blood cells. This may at times bring about complete cessation of the function of such organs as the bone marrow and may eventually lead to death. In spite of the occurrence of such physician-induced diseases, one must not adopt a negative attitude towards drug therapy. The more that is known about the mechanisms of drug action and the fate of drugs in the body, the easier it will be to prevent the occurrence of such side reactions through a more judicious and rational approach to the use of the best drug for a specific condition.

The discipline of pharmacology extends into many areas of the health sciences. If its impact on human medicine is strong, it is equally important in veterinary medicine. For economic as well as for humane purposes, pharmacology has become one of the most important branches of veterinary medicine. The eradication of disease in domestic and wild animals is important by itself but also extremely important in the case of diseases that can be transmitted from animals to humans. Economically, drugs are important for lengthening the life span of animals as well as for increasing their productivity and rate of growth.

Many of the drugs administered to animals either for the treatment of infection or the acceleration of growth may be found in very small quantities in their meat or milk. The study of such drugs residues is essential since human populations may

become repeatedly exposed to small doses of drugs. Such drugs may also be present in doses large enough to induce changes in the normal reaction of these individuals to a re-exposure to the same substances. For example, exposure to small amounts of an antibiotic may produce resistance to the further administration of the substance and render therapy with this antibiotic ineffective.

Comparative pharmacology is concerned with the variation of drug effects and drug metabolism in different animal species. It is a most worthwhile endeavour that may uncover unsuspected similarities between the human and other species and afford new tools for the study of drug effects and drug metabolism.

Numerous areas of interaction have been developed between pharmacology and other biomedical disciplines. Recently, the closer contact between pharmacology and genetics has produced an interesting new branch called pharmacogenetics. This discipline deals with the modification of pharmacological responses by hereditary influences. It has already provided much useful information leading to a better understanding and screening of various abnormal drug responses. The field of experimental pathology has developed ties with pharmacology through the use of drugs and poisons to produce in laboratory animals various conditions similar to the naturally occurring disease processes. Through developmental pharmacology, a fruitful relationship has been established between pediatrics and pharmacology, by studies on the biochemical differences between the foetus and the newborn on the one hand and the adult on the other, and the consequences thereof on the efficacy, metabolism, and toxicity of drugs.

In agriculture, the importance of pharmacology and toxicology continues to be manifest. Widespread use of pesticides, fertilizers, and food preservatives has had an enormous economic impact, but it has also brought new hazards to man by adding more toxic residues in the diet and by increasing the risks of intoxication from direct contact with these potent chemicals.

It is expected that, in the decades to come, pharmacology will continue to grow at an even faster rate, and it would be an understatement to say that drugs will be most important in the life of individuals and of communities of the future. Ways to control the growth of the world population through the use of contraceptives are at our doorstep. The widespread use of tranquilizers, anti-depressants and mood-altering drugs which include psychedelic compounds are also clear indications of the role which drugs may play in tomorrow's civilization of leisure.

PART II. Science Policy and the Growth of Canadian Pharmacology

1. The Importance of Drug Research for Canada

In establishing a science policy for the health disciplines, drug research should be given a high priority. Indeed, drugs continue to be one of the major forms of therapy and the health of the nation heavily depends on their intelligent usage. The rational use of drugs in modern society is possible only in a setting where a well-informed medical community can rely on and be stimulated by active groups of basic and applied scientists involved in four types of activities: the development of new drugs by industry, the alert appraisal of the safety and efficacy of new drugs by government regulatory bodies, the elaborate studies on the mechanisms of drug action, and toxicity in basic research laboratories, and the critical assessment of the therapeutic efficacy and the side effects of drugs in humans. Any science policy should take into account the need to help develop these four related fields of endeavour and to facilitate their coordination.

In order to benefit fully from the discoveries and applications originating in other countries, Canada must develop a position of leadership in some areas of pharmacological research. This is an important factor in the development of a Canadian identity and of a partnership relation with other countries rather than one of dependence.

A solid foundation in basic and applied research is also essential for the development of an objective and critical attitude in areas of drug legislation, distribution and usage. The well-informed advisors, with experience in the scientific way of thinking, required by various

government agencies and departments, will not sprout elsewhere than in active laboratories grouping competent research workers.

2. The Need for Manpower in Canadian Pharmacology

In a recent report to the Medical Research Council of Canada, entitled "Canadian Medical Research: Survey and Outlook, Report Number 2, 1968" the needs for medical manpower in Canadian departments of pharmacology were realistically assessed. Approximately 100 new positions have become or will become available in these departments by 1972. Some of these positions have already been filled, but many more candidates will be required, in the older as well as in the new and developing medical schools. Many of the good pharmacology graduates in Canadian medical schools will be attracted by academic medicine, but their number will probably not be large enough to fill all the positions available. As they have done in the past, pharmacology departments will still have to rely on foreign sources of supply to satisfy some of their needs in professional personnel. For recruiting some of these new staff members, it is essential that the personnel support programmes of the Medical Research Council, of the Heart Foundations and of other granting agencies be maintained.

Government laboratories and those in the drug industry will also require a large number of full-time research workers in pharmacology and toxicology during the next five years. New research facilities are being developed by the Canadian drug industry and others are planned in the near future. The projected needs of the Food and Drug Laboratories also call

for an important increase in the number of scientists in the drug field.

3. The Need for Adequate Research Space and Facilities.

The available research space in Canadian pharmacology departments was expected to increase by 116% from 1967 to 1972. The expansion that has occurred during the last two years and the projected developments during the next three years are such that the total floor space projected for 1972 will probably become available. Whereas more space than that which was projected could be used quite profitably, it looks as if research space may not be the limiting factor in a few years from now, except in a few departments. Yet, to attain these goals, the present granting policies must be maintained and the commitments by the universities and the local governments must be honoured.

That which could become an important limiting factor is the quality of the research facilities. Research in basic and applied pharmacology, as in other related disciplines, has become very sophisticated. Efficient productivity rests not only on the availability of qualified professional and technical personnel, but also on up-to-date analytical tools, effective methods of searching the scientific literature and competent programming and data analysis. Present policies and budget must not only be maintained at their present level but should also be increased to take into account the higher level of sophistication, the increased cost of equipment and the higher salaries requested by the research personnel.

4. Special Areas in Need of Development

The strength of Canadian pharmacology resides primarily in the field of drugs acting on the autonomic nervous system and the cardiovascular system, but there are scattered areas of excellence in pharmacogenetics, biochemical pharmacology, neuropharmacology, the pharmacology of anti-coagulants, endocrinology and smooth and skeletal muscle physiology. Among the areas in great need of development are: clinical pharmacology, drug metabolism and toxicology, drug screening, psychopharmacology and molecular pharmacology.

Clinical pharmacology has had a good start in a number of departments. Some of the units that have been developed in recent years have already become good centers of training. New clinical pharmacology units are required throughout the country and those in existence need to be strengthened. Because of its practical nature and its great usefulness in bridging the gap between basic pharmacology and therapeutics, it should be given a high priority in the context of a health science policy. The Medical Research Council and other public and private agencies have generously contributed to the development of clinical pharmacology in Canada, but one private agency in particular, the Canadian Foundation for the Advancement of Therapeutics, has played a key role in the development of this discipline. The modest budget of this foundation is made up of contributions from pharmaceutical houses adhering to the Pharmaceutical Manufacturers Association of Canada. This is one example of a most fruitful collaboration between the drug industry and the university. Most of the budget of this Foundation is used for the maintenance of clinical pharmacology units and for the training of professional personnel.

In 1968, a committee was established by the Medical Research Council to look into the need for special development in the study of toxicology and drug metabolism. The committee found serious deficiencies in the research effort, the personnel, and the laboratory facilities devoted to research in these two fields in spite of their increasing importance in health care. In order to strengthen research in these related areas, the committee recommended that the Medical Research Council invite schools of medicine and pharmacy to submit proposals for the establishment of groups of research workers in these related fields, as an initial step towards the future development of permanent research institutes in toxicology and drug metabolism located on a university campus in close administrative relationship with university departments. The Medical Research Council approved this recommendation and plans are now underway in several medical schools for setting up such research groups. It is hoped that the Medical Research Council and the universities will be in a position to support the establishment of such research units.

A committee of the Medical Research Council of Canada has also embarked on a study of the problem of drug screening in Canada. Organic and medicinal chemists in departments of chemistry, schools of pharmacy and medical schools synthesize every year a large number of compounds that are tested outside Canada because of the virtual absence of an organization in this country that will provide biological screening of these compounds. This results in the loss of potential economic benefits to the country. One solution would be the allocation of a special grant to a private institute in order to screen all new molecules synthesized in university settings in Canada. Compounds of potential therapeutic value could then be offered for further testing and marketing to the Canadian drug industry, through an agency such as the Canadian Patent and Development Limited.

Collaborative efforts between the university and the Canadian industry in the area of drug screening could bring important gains to both groups involved.

One very important aim of present-day research in pharmacology is the development of an understanding of the mode of action of drugs in precise chemical terms. Unfortunately, very few scientists are presently involved in the field of molecular pharmacology in departments of pharmacology in Canada, and it is hoped that ways will be found to develop this area in the near future.

We have defined five major areas in need of development. There are others, of course, but the areas stressed here represent fields of endeavour where progress would be most significant from academic as well as economic standpoints.

5. Research in the Drug Industry

A number of Canadian drug firms are actively engaged in biological and medical research programmes. These programmes are primarily orientated towards the synthesis of new drugs, the study of their properties and of their therapeutic potential and the analysis of their purity and toxicity. However, a modest volume of research is undertaken on basic problems without clear relevance to the primary goal.

Important budgets are provided and a competent personnel is at work in facilities that are often better than those found in medical schools. Important research contributions have already been made in these laboratories and a large number of research projects presently pursued are of very good quality. This research component is therefore far from being negli-

gible and we agree with the conclusions brought forward in Chapter 20 of the Report to the MRC (1968, No. 2), namely that "The industrial complement of the country's research effort is an essential one, and that the strengthening of pharmaceutical research would be an important development for the health sciences in Canada. Over and above the addition it would in itself make to our total scientific resources in the health field, it would result in an enlargement of view and opportunity for medical scientists in our universities."

In developing its science policy, the government should therefore take into account the need for bringing closer together the drug industry and the university departments of pharmacology, especially in the areas of drug development, toxicity and clinical pharmacology.

PART III. General Consideration on Canadian Science Policy

1. A Canadian Science Policy

The Senate Committee on Science Policy is to be complimented for setting up a forum in which societies, government and private organizations and all citizens can present their points of view. Not only does it provide a useful channel for the gathering of information, but it also serves as an incentive for all concerned to clearly define their objectives in a realistic overall Canadian perspective.

National goals in scientific affairs must be established, through a coordinating mechanism allowing the participation of scientists and concerned citizens at the various levels of organization, from the base of the scientific community up to the higher administrative and advisory levels.

Since science is an all pervading activity, it is believed that it would be unrealistic to establish a federal Department of Scientific Affairs. Neither should there be a Minister of Science Affairs without a Department.

Other mechanisms must be found to centralize scientific affairs. One such mechanism could be the maintenance of the Special Committee on Science Policy, which could become a standing Committee of the Senate, and act as a permanent public forum for the expression of the views of all concerned.

Advice about scientific and technological matters must be sought at the various organizational levels, i.e. renowned scientists and respected informed citizens, individual scientific societies and institutions, groups of societies and institutions, research agencies, the Science Council, and scientific advisors at Cabinet level. A free flow of communication from these various levels to the level of the decision-makers is essential.

Short-term and long-term objectives must be clearly defined and systematically reviewed. In choosing the means to attain these objectives and in the setting of priorities the policy-makers should allow for flexibility and diversity and guard themselves against rigid and monolithic schemes.

2. International Objectives

Canada is one of the more privileged nations of the world and it should be called upon to play a more important role in helping less privileged countries to attain a higher scientific and technological level. Other assets of our country being its bilingual character and its lack of imperialistic views, we are in a unique situation to provide scientific and technical guidance and material help to many nations, such as the new array of intermingled French or English-speaking states of the African continent.

3. Priority of Medical Research

The federal government, in conjunction with the provinces, are now committed to provide extended health care for Canadians, and many health service and training facilities are being expanded. In order to recruit and retain the required teacher-scientists in medical and other health science schools, in university affiliated hospitals and research institutes, biomedical research must be given a high priority and adequate research funds must be provided. This is essential for the maintenance of the high level of knowledge of medical researchers and teachers and of the high quality of services given by the health practitioners. The Canadian public cannot expect less than the best when its health is at stake.

4. Research Support

The federal granting agencies should continue to bear the major responsibility for the support of biomedical research in this country. The provinces nonetheless have an important role to play in providing the training grants and the capital investment and start-up funds required by young scientists.

The Medical Research Council of Canada, the major granting agency in the biomedical field, has played a most decisive role in fostering the development of research in the biomedical sciences, and, with the funds at its disposal, it has done a most efficient job of grants distribution. In recent years, the more rapid rate of growth of the budget of the MRC has strengthened many areas of excellence and has allowed a large number of promising research laboratories to attain a satisfactory degree of productivity. It has also provided many young investigators with the means to establish their reputation as productive and original research workers. More recently, the slower rate of increase of the budget has caused much concern. Many fear that they will be limited in their projected developments and that the establishment of the required laboratories in developing medical schools may be retarded. It is hoped that the budget of the MRC will continue to grow at least at the same rate as during the years 1966 to 1968.

The voluntary health agencies have played a less important but nonetheless significant role in the development of biomedical research. In establishing a Canadian science policy, it should be recognized that the voluntary health agencies, such as the Canadian Heart Foundation, the National Cancer Institute, the Muscular Dystrophy Association of Canada, and others, will continue to play a most useful complementary

role in the continued development of biomedical research.

Most Canadian universities do not support directly the research endeavours of their staff. They nevertheless contribute a fair share of the overall cost of research by providing the salaries of the majority of investigators, as well as the basic facilities and most overhead expenses. What is perhaps lacking in many Canadian universities is, in fact, a well-defined science policy. At the same time that the government of Canada is seriously working at the task of defining such a policy for the whole country, it would be profitable to all if the universities themselves would thoroughly analyze their position vis-a-vis science.

5. Research Institutes

Some members of the Society believe that research institutes outside the existing university framework should be established for those scientists interested primarily in research and much less in carrying simultaneously the burden of teaching and administrative duties. However, the majority would not favour the setting-up of such drug research or other specialized institutes. They believe that these developments should occur in close physical relationship with existing university departments, in the hope that the latter would be strengthened by the establishment of such units rather than weakened by the loss of their good people and by shift of emphasis from university-based research to that undertaken outside universities.

APPENDIX 190

SUBMISSION

TO THE

SPECIAL COMMITTEE ON SCIENCE POLICY OF THE SENATE

BY THE

ASSOCIATION OF DEANS OF PHARMACY OF CANADA

A. W. Matthews, Sec.-Treas.

F. N. Hughes, President.

April, 1969.

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1.0 Purpose

The purpose of this submission is to outline the present state of development of pharmaceutical education and research and their relation to the other health sciences and to health-related research. Recommendations are made as to some of the ways in which government science policy might be expected to enhance the development of the health sciences and drug-related research.

2.0 Identification

The Association of Deans of Pharmacy of Canada consists of the eight deans and directors of the faculties and schools of pharmacy in Canada, as follows:

Dean B. E. Riedel, Faculty of Pharmaceutical Sciences, University of British Columbia.

Dean M. J. Huston, Faculty of Pharmacy and Pharmaceutical Sciences, University of Alberta.

Dean W. C. MacAulay, College of Pharmacy, University of Saskatchewan.

Professor J. R. Murray, School of Pharmacy, University of Manitoba.

Dean F. N. Hughes, Faculty of Pharmacy, University of Toronto.

Dean J. Tremblay, Faculty of Pharmacy, University of Montreal.

Professor P. Claveau, School of Pharmacy, Laval University.

Professor J. G. Duff, College of Pharmacy, Dalhousie University.

It is an affiliate of the Association of Universities and Colleges of Canada.

3.0 Summary of Recommendations

3.1 On the principle that its role in the development of research should be, in the main, one of support, the Government should continue to expand the scope of the existing Medical Research Council to enable it to function for the total health sciences research field.

3.2 With respect to health-related research generally, and to drug-related research in particular, Government science policy should include the objective of attaining a high degree of

collaboration between industry, the universities and government. Efforts should be directed toward concentration in specific areas with a view to developing "centres of excellence" in order that Canadian research may make a contribution which is unique.

3.3 Government policy of supporting drug-oriented research should make adequate provision for fostering basic research in the universities.

3.4 The Government should give consideration to fostering regular conferences and/or establishing an institute for higher studies on drugs with a view to the long-range planning of mission-oriented programmes. Government's role should be aimed at bringing about maximum cooperation between industry, the universities and the health professions with a minimum of regulation.

3.5 The Government should encourage long-range planning of the manpower resources requirements for health-related research in Canada and should set up a joint university-industry advisory committee to further graduate programmes through exchange of information and in other ways.

3.6 The Government should assume the central role in organizing and developing an adequate data storage and retrieval system for the health sciences. This system should be designed to serve both the needs of research workers and health professionals.

4.0 Scope of Modern Pharmacy

4.1 The nature of modern pharmaceutical practice relates directly to current trends in the delivery of health care. Today, technological, economic and social innovations appear to be taking place at an ever accelerating pace. This obviously is true in the field of the health sciences and the emerging pattern of health care is forcing a redefinition of the roles of health professionals. Modern developments which are usually referred to as "medical" advances include many new breakthroughs which are more specifically "pharmaceutical" in nature. The pharmaceutical scientist, together with his colleagues in chemistry and in the biological sciences, has introduced a new era in therapeutic agents -- more specific,

more potent, more complex, more effective, but at the same time potentially more dangerous remedies if misused.

4.2 There can be no doubt that the technology of the chemical and pharmaceutical industries has placed a great and increasing responsibility upon the profession of pharmacy. The products of these industries, whether obtained through proper and established channels or by devious methods, reach the hands of a public not capable of sufficiently understanding them or of appreciating the dangers associated with their use. Recognized as the expert on drugs, the pharmacist also has the scientific background which enables him to understand the chemical nature, the intricacies of use and the inherent dangers of pesticides, herbicides and other toxic substances. In the specialized field of drug action he is perhaps more sensitive than most of the problems of misuse and abuse of drugs and appreciative of the growing importance of the drug use control function which he performs.

4.3 The traditional role of the pharmacist essentially has been to provide a service which will ensure safety of patients and protection of the public in respect to the distribution of drugs. This is equally applicable to community pharmacy and to pharmacy as practiced in an institutional setting (hospitals, nursing homes, etc.). The functions performed by the practitioner in providing an adequate pharmaceutical service include those outlined in Appendix A.

4.4 In hospitals the responsibilities which devolve upon the pharmacist go beyond those traditionally associated with community practice and may involve him in the processing of injectable medication and other special formulations. He is also responsible for the establishment of efficient and safe procedures for drug distribution in the institution, as well as the controlled pre-packaging of drug products. In the larger institutions he may be involved in the clinical investigation of new drugs, the reporting of adverse drug reactions and in providing a drug information service to the other members of the health team.

4.5 No brief summary of the scope of modern pharmacy would be complete without mention of services performed by pharmacists in industry and in the government service. In the pharmaceutical manufacturing industry the specialized knowledge of pharmacists is utilized in production and control, in research and development, and in marketing. At the federal level of government, pharmacists serve in the food and drug laboratories, in the narcotic control division and in armed forces. At the provincial level pharmacists serve in connection with the procurement, testing and distribution of drugs in the operation of various provincial institutions and in connection with welfare and other programmes.

5.0 The Present Status of Pharmaceutical Education

5.1 The development of pharmaceutical education to the stage where it has attained the status of a university discipline has taken place in English-speaking countries almost entirely in this century. In 1900, medicines were relatively few in number and mostly of natural origin. With the advent of synthetic chemistry and as drugs became more complex in nature, training through apprenticeship under a practicing pharmacist proved inadequate so the necessity for an appropriate background in the physical and biological sciences became apparent. In the older provinces of Canada instruction in botany, chemistry and in professional courses first was provided in proprietary schools and was closely tied in with the apprenticeship training. Eventually, however, it was realized that a more formal and scientific educational programme was indicated and that it could best be provided by the universities. The course of studies has developed through one and two-year courses leading to a diploma to, first, a three-year degree programme and, currently, a four-year course leading to the bachelor of science in Pharmacy. The standard of entrance for this course is senior matriculation.

5.2 The degree in Pharmacy now is offered, in the West at the Universities of British Columbia, Alberta, Saskatchewan, and Manitoba; in Ontario, at the University of Toronto; in Quebec, at

the University of Montreal and Laval University; and, in the Maritimes, at Dalhousie University. The need for some co-ordination of pharmaceutical education in the various provinces of Canada was recognized early and, with the formation of the Canadian Pharmaceutical Association in 1908, a Committee on Education was established. In 1944 the Association was instrumental in bringing about the organization of the Canadian Conference of Pharmaceutical Faculties. This Conference has played a major role in improving and co-ordinating the curricula in the several colleges.

5.3 The curriculum for pharmacy, which, even subsequent to the attainment of the status of an academic discipline, for many years was largely oriented to community practice, of late years has undergone extensive expansion and enrichment. In common with other professions, Pharmacy as been characterized by both knowledge and skill and historically, as with the others, the knowledge part of the armamentarium, once mastered, remained essentially static. This is not the case today when there exists what amounts to a knowledge explosion. As knowledge in the physical and biological sciences continues to expand at an ever increasing rate a natural consequence is more and more fragmentation and the necessity for specialization. The point already has been passed where it is possible to speak of the pharmaceutical sciences as a single special field and one must now recognize special fields within the area of the pharmaceutical sciences. These special fields may be identified as Pharmaceutics, Biopharmaceutics, Pharmaceutical Chemistry, Pharmacognosy, Pharmacology and Bionucleonics.

5.4 Faced with an apparent need for a reorientation of pharmaceutical education, curriculum planners within the Canadian Conference of Pharmaceutical Faculties were confronted with the difficult task of preserving a core programme designed to provide adequate professional education and, at the same

time, insuring that those students whose interests lay in the deeper study of pharmaceutical science are provided with a suitable foundation. Naturally, the challenging task of preparing graduate pharmacists to take their places as health professionals qualified to perform their specific functions in the delivery of health care services remains the principal function of the undergraduate programme. Because of the significant proportion of students who wish to continue with more advanced studies, the colleges of pharmacy also are making their contribution to the preparation of well-trained pharmaceutical scientists through the development of their graduate programmes.

6.0 Development of Graduate Study and Research in the Pharmaceutical Sciences

6.1 As was the case with the universities generally, the colleges of pharmacy were caught up in 1945 by a sudden influx of post-war students for which they were ill prepared in respect to both staff and facilities. However, sufficient progress in overcoming some of the major difficulties had been made by the early 1950's to permit the initiating of graduate study and research programmes. In general, the goal of pharmaceutical research is to advance knowledge in the pharmaceutical sciences and the related basic sciences. The pharmaceutical sciences have both physical and biological components and embrace a wide spectrum of subject matter. The pharmaceutical scientist may be concerned with any aspect of the chemical or physical nature of a drug or the biological processes it influences. Present research programmes are centered in the fields of pharmaceutical and medicinal chemistry, pharmaceutics, pharmacognosy, pharmacology and bionucleonics.

Pharmaceutics, in its modern concept, emphasizes physico-chemical and mathematical approaches to evaluating and understanding the reactions and interactions of drugs and the design and efficacy of pharmaceutical systems (dosage forms). Considerable attention is now paid to problems involved in the complexing of medicinal agents, the stability of medicinal agents in solution, the kinetics of degradation of an active agent in solution and to a variety of other formulation problems. Research interests range from almost pure physical chemistry, such as models describing the dissolution behaviour of solids, to pure pharmacology, such as the pharmokinetics of salicylate absorption, metabolism, and excretion. The term "bio-pharmaceutics" is now used to denote the sub-area devoted specifically to the study of availability "in vivo" of medication from pharmaceutical systems.

Pharmaceutical Chemistry - Research in pharmaceutical chemistry is becoming increasingly interdisciplinary in respect to its involvement in chemistry and in biology. In general, the areas of research interest may be concerned with analytical pharmaceutical methods and other aspects of quality control, synthesis of new compounds and chemical modification of drugs of known structure, or with the investigation of relationships between chemical structure and physiological action.

Pharmacognosy - in its classical form was closely allied with botany and was concerned with drugs of natural origin. In its modern connotation pharmacognosy is now much more closely related to chemistry and biochemistry and is essentially a study of natural products as they relate to drugs. Research interests may centre around the extraction, identification, and characterization of plant principles and studies of factors influencing growth of plants and yield of active principles, including tracer biosynthetic

studies.

Pharmacology - has evolved into a multi-disciplinary science which utilizes other sciences such as chemistry, zoology, anatomy, biochemistry, physiology and pharmaceutics. In studies of structure-activity relationships there is a close relationship with research in pharmaceutical chemistry. Research interests will include the basic mechanisms of drug action, studies of dosage, toxicity, action and fate of drugs in animals, effect of drugs on isolated organs and tissues, influence of drugs upon biochemical phenomena. One of the most active and significant areas of research today is in clinical pharmacology and drug metabolism.

Bionucleonics - In bionucleonics, as applied to problems of pharmacy, studies involve the use of radioisotopes as diagnostic and therapeutic agents; both radioisotopes and radiations of several types are used as research tools. There are many problems of formulation to be solved especially in the use of various short-lived radioisotopes. Hence "radiopharmacy" is becoming an important sub-specialty today.

6.2 Prior to the year 1968 the members of staffs in the colleges of pharmacy received the greater proportion of their research support through the National Research Council. The total of such grants was not an impressive figure and lesser amounts were made available through a limited number of grants from Defense Research Board and other sources. In 1967, at the request of the Association of Deans of Pharmacy of Canada the Medical Research Council carried out an assessment of the research facilities and personnel in the colleges of pharmacy and, subsequently, the Council in 1967 agreed to recognize pharmacy as a discipline within the framework of M.R.C. It would be difficult to overstate the significance of this important development and the stimulus that this recognition and the resultant very greatly increased financial support already have provided to pharmaceutical

research in the schools of pharmacy.

6.3 The present space available for research in schools of pharmacy is of the order of 44,000 sq. ft., with firm plans for an increase to 50,000 plus sq. ft. There are plans, also, to increase the full time complement of staff members from approximately 70 to perhaps 120 over the next five years. Recently a number of quite senior pharmaceutical scientists have come from outside Canada to join the staffs of the colleges. There can be little doubt that the increased support for research now being provided has been a factor in this migration.

6.4 Statistics compiled by the Association of Deans of Pharmacy of Canada indicate that since 1950 there has been a dramatic increase in the number of B.Sc. in Pharmacy graduates who have gone on to Ph.D. degrees in Canada and in the United States. Since 1960, 58 have continued on to the Ph.D. level and 80 per cent of these have located in Canada after graduation. In the year 1966-67, 55 graduates were enrolled in Ph.D. programmes, mainly in U.S. universities. Ten year projections for staff requirements in Canadian and U.S. colleges of pharmacy indicate a demand for these specialties beyond the foreseeable supply. It is significant, also, that many new Ph.D.'s with a pharmacy background seek appointments as teachers in the basic medical sciences and others are attracted to the pharmaceutical industry.

6.5 In summary, it may be stated that the development of graduate programmes and the expansion of research in the colleges of pharmacy are moving rapidly forward. All colleges offer the M.Sc. degree and four now accept candidates for the Ph.D. degree. Others collaborate with departments of chemistry, biochemistry and pharmacology in joint programmes. The colleges are developing these programmes in confident expectation that there will be continued expansion of the pharmaceutical sciences in the academic area, in industry and in the government services.

7.0 Pharmaceutical Sciences in Relation to the Development of the Health Sciences

7.1 Health-related research has become a very complex enterprise involving scientists of many diverse backgrounds and interests. It is recognized that the old-established borderlines between the sciences are disappearing as our knowledge expands. This is particularly true in the biological sciences. It is not appropriate, or timely, therefore, that any serious effort should be made to compartmentize pharmaceutical sciences in distinction from the physical and biological sciences, on the one hand, and the medical sciences, on the other. It is perhaps sufficient to point out that research in the pharmaceutical sciences is interdisciplinary and the scientist usually is applying principles from one or more of the other sciences in an investigation which is drug-oriented, as distinct, for example, from the medical scientist whose objectives may be disease-oriented or treatment-oriented.

7.2 Essentially and broadly pharmaceutical research is concerned with drugs -- their isolation from natural sources, synthesis, physiological action, toxicity, formulation of dosage forms, analysis, stability, metabolism. An index of projects currently in progress in Canadian colleges of pharmacy would reveal interest in both basic and applied research. It would include the isolation and identification of drugs from natural sources, the synthesis of new medicinal compounds; the elucidation of the mechanism of action of drugs, their pharmacological action, toxicity, preservation, analyses and standardization, absorption and excretion, and presentation in suitable dosage forms.

7.3 While the contribution of pharmaceutical research to the development of the health sciences is not, and should not be, confined within narrow boundaries, there probably are several areas where pharmaceutical scientists might be considered to have particular responsibilities. In pharmaceutics the modern physicochemical orientation is leading research into the very rapidly

developing sub-area of biopharmaceutics - the study of the availability in vivo of medication from pharmaceutical systems. The pharmokinetics of absorption, metabolism and excretion of drugs provides the base on which modern dosage forms are structured. In pharmaceutical chemistry, chromatography, spectrophotometry and other modern methods are opening doors to the evaluation of the structure and purity of drugs and to more effective and efficient quality control operations and analytical procedures. Research into the relationships between physical and chemical properties and biological activity is providing a bridge between medicinal chemistry and pharmacology. Studies in the mechanisms of drug action utilize both biochemical and pharmacological techniques. Research in the areas of drug metabolism and toxicology can be expected to provide the kinds of information needed in practice if the pharmacist is to accept a role which will require a greater clinical orientation, as now is being forecast for him.

7.4 In summary, it may be said that, due to the interdisciplinary nature of the interest in drugs and drug action, research on drugs may receive attention in several physical science and health science university departments. For this reason, it could be highly advantageous to have some correlation of the research on drugs within a university in order to minimize duplication of effort and maximize productivity. Because in the colleges of pharmacy drug development and usage are of primary concern, it would seem that they are in a unique position to play a leading role in drawing together the diverse group of research interests in order best to promote and develop available skills.

8.0 Drug-related Research and Government Science Policy

8.1 Because health-related research has become a very complex and expensive enterprise, it appears to be desirable that a high degree of cooperation be developed between the government, the universities and industry in order that today's health goals may be achieved. Each sector has its own unique contribution

to make; government through its financial resources and its capabilities to assess national needs and to formulate national goals; the academic institutions by their traditions of scholarly excellence and scientific freedom; industry through its great developmental capabilities and established record for ingenuity and creative application.

8.2 Even though a closer and effective liaison between government, the universities and industry is achieved, the fact still remains that the research potential in Canada is somewhat limited in relation to larger and older countries. Thus, if a unique contribution is to be made through pharmaceutical research done in Canada, it would appear to be poor policy to attempt to cover the broad spectrum of possible activities. Rather, Canadian efforts should be concentrated in specific areas with a view to developing "centres of excellence" and the highest levels of achievement.

8.3 Movement in the direction indicated above would seem to require an about-face from present trends. The record of the Canadian pharmaceutical industry in aiding and fostering research in the colleges of pharmacy has been far from impressive. Financial support has been on a very limited scale and has come, in the main, indirectly through the Canadian Foundation for the Advancement of Pharmacy. An annual research conference, initiated some twenty years ago by the Canadian Foundation for the Advancement of Pharmacy and the Canadian Conference of Pharmaceutical Faculties, has had only token recognition and support from industry. It seems logical to postulate that the legislation presently before the House of Commons to amend the Patent Act, the Trade Marks Act and the Food and Drugs Act (Bill C-102) reflects a lack of understanding and collaboration between industry and government with respect to the goals and achievements of the former's research policy.

8.4 If, as has been widely claimed, Bill C-102 may have the effect of lessening incentive on the part of Canadian

Pharmaceutical Manufacturers to maintain research programmes in this Country, the present would appear to be a most appropriate time to initiate a series of conferences to review both short and long-range policies calculated to draw together all investigators in research in the pharmaceutical sciences and ultimately to establish clearly defined joint goals. Review and discussion of the orientation of present programmes could be a preliminary step to the establishment of areas of primary interest which each of the three partners, government, industry and the universities would feel are best suited to their personnel and facilities.

8.5 Another important area where cooperation would benefit all is that of the training of personnel. The faculties and schools of pharmacy, established as they are in major Canadian universities, have reached the stage now where they are in a position to make greater contributions to training of research personnel. Their graduate programmes function within the environment of the health-related sciences and possess the multidisciplinary components that are required for the training of individuals who expect to make a career in drug research. These young scientists, during their graduate programmes, would benefit from closer contact with the facilities and the investigators to be found in the research laboratories of both government and industry. Arrangements for short periods of exposure to the conditions in off-campus laboratories might be considered. Periods of appointment as visiting professors might be arranged for scientists in government and industrial laboratories to the mutual benefit of the individuals concerned and to the graduate programmes. Of interest, and signficance in this connection are two recommendations which emerged from a recent colloquium jointly organized by the University of Paris and the pharmaceutical industry of France:

(i) That an institute of higher studies on drugs be organized whose main responsibilities would be to coordinate the

various specialized programmes of studies leading to certificates or diplomas of specialization;

(ii) That a joint University-Industry committee be appointed whose terms of reference would be to identify the main topics of interest that should be developed within the undergraduate and graduate programmes of studies and training, to promote exchange of information and exchange of individuals and to facilitate the development of joint research programmes.

8.6 It is probable that one of the most productive types of collaboration between government, industry and the universities may be found to lie in the area of communication. Indeed modern developments in electronic data processing may make it possible, in one giant step, to progress from an existing state of little or no communication to the stage where a research group, or indeed a single worker, may have access immediately on request to the accumulated knowledge in a specific field.

8.7 In both the health-related scientific and professional fields the available literature is enormous, much of it currently undigested. Specialists in restricted areas are assisted by such media as annual reviews, and abstract services. The advent of the computer age now gives promise of a system for providing selective information adaptable to the whole health field. Both in government and in the universities facilities already exist to acquire and store information. It will require a considerable amount of organization to develop the needed facilities for a proper input into the system and effective methods of dissemination. Governments could take a leading role in drawing together the resources of industry, the universities and the health professions with a view to setting up and maintaining a continuing systems analysis appropriate to a communications network for the mutual benefit of the partners.

Respectfully submitted on behalf of the Association of Deans of Pharmacy of Canada.

A. W. Matthews, Secretary-Treasurer.

F. N. Hughes, President.

April, 1969.

APPENDIX A

The functions fulfilled by the practitioner in providing an adequate pharmaceutical service are as follows:

1. to protect the public against the misuse and abuse of drugs;
2. to compound and dispense drugs and therapeutic agents as prescribed by the qualified medical practitioner;
3. to certify that the prescribed medication is safe, potent and correct;
4. to maintain an adequate and properly stored stock of drugs;
5. to keep records of all prescriptions for the convenience and protection of the patient and the prescriber;
6. to keep up-to-date on all new therapeutic measures;
7. to maintain a library and other reference material on pharmaceutical products;
8. to act as consultant on drugs to the medical practitioner and other members of the health professions;
9. to control the distribution of narcotics and other restricted drugs;
10. to control the distribution of poisons;
11. to act as consultant on health matters to the general public, both individually and collectively;
12. to offer first aid when required;
13. to participate in Emergency Health Services planning and operation;
14. to distribute health needs such as first aid equipment, surgical supplies, sick-room supplies, vitamins, etc.;
15. to distribute and provide information on veterinary supplies, herbicides, rodenticides, insecticides, etc.
16. to participate as an educated and responsible citizen in the affairs of the community and the country;
17. many pharmacists in areas other than retail pharmacy, by reason of the nature of their employment make special contributions such as those in hospitals, laboratories, etc.

APPENDIX 191

SNC ENTERPRISES LTD.

SUBMISSION

TO THE SPECIAL COMMITTEE

ON

SCIENCE POLICY

OF

THE SENATE OF CANADA

1550 Maisonneuve Blvd West
Montreal 107, Que.

August 1969

CONTENTS

SUMMARY AND RECOMMENDATIONS

INTRODUCTION: THE PREMISES

1. Increasingly we live in a man-made world; the sciences will have profound effects on Canada as a nation and as a place to live and to work.
2. Canada's basic asset is its people. Accordingly, policy should set ground rules for creating an environment conducive to the full development of individuals.
3. As Canadians we must excel in what we choose to do; building on our strengths to surmount the challenges of world competition.
4. All Canadians are responsible for bringing about innovation, dynamism, and growth. One of the objectives of a science policy, and definitely a role of Government, is to stimulate and encourage people to accept this responsibility.
5. Canada's economic future depends on the ability of Canadians to export products and services.

THE NEED: INNOVATION

6. Science Policy must develop creativity and management capability to capitalize on innovation in any sector, rather than set out rigid priorities in specific problem areas.
7. Making and exploiting inventions and discoveries is the main process that differentiates the rate of progress of the United States from that of the rest of the world. The focus of innovation in the United States has been on the future rather than the past; supplanting rather than resolving old problems.

RECOMMENDATION 1: Science Policy cannot be directed at the problems of yesterday or the technologies of today. To meet the challenges of tomorrow, it must concern itself with the process of development rather than with a set of specific problems.

The main thrust of a Canadian Science Policy should be toward understanding and stimulating the process of innovation.

8. Success in business today is due as much to a State of Mind as a State of Size. Accordingly,

RECOMMENDATION 2: Science Policy should support Canadian organizations that feature:

- ventures and services to improve the environment of man,
- high investment appeal,
- an innovative, opportunity-oriented, approach.

9. Canada must develop its innovative skills if it is to continue its diversified industrial expansion. Useful products and services and long-term profitability are the result of innovation. Innovation is much broader than innovation in ideas or discovery: it includes financing, production, marketing, etc. But the innovative advantage disappears as soon as the innovation becomes routine. Accordingly, innovation must be a continuing activity.

RECOMMENDATION 3: Science Policy should stimulate communication between innovators in ideas or invention, and innovators in finance, development, production, and marketing.

Science Policy should encourage simpler and more adequate world-wide patent and copyright protection for the individual backed by the full power of the Canadian Government.

Amateurs and professionals should be on the same basis for tax incentives to invention, discovery, and innovation.

There should be follow-through in innovation support or subsidy to cover all the aspects of innovation from ideas to market impact.

10. The firm or organization engaging in research and development or in innovation should have a well-defined corporate plan for harnessing the results. This planning approach is more important than the nature of the innovation because it tests the worth of the innovation pragmatically, in terms of the market.

11. Canada will only be able to come to grips with its physical, social, and economic problems if it has a strong and growing economy. National Goals will not in themselves provide the stimulus required; they can however assist in directing some of the available energies and skills toward the solution of pressing national problems.

RECOMMENDATION 4: Government support for private research and development should be made conditional on the preparation of a plan that relates the roles of research and development to the other corporate functions.

12. Risk capital is needed if innovation is to succeed. But Government, by its nature, is not suited to act as a "Review Board" on the distribution of risk capital. Government can, however, take positive measures to encourage innovation.

13. Applied research today is not concerned in the main with expanding the number of scientific discoveries, but with exploring how industry can exploit discoveries in many ways. The Time Gap from fundamental discovery or innovation to Industrial Impact, and the Dimensions of Industrial Impact, are fundamental and crucial parameters for a Science Policy to consider.

RECOMMENDATION 5: The Government should provide tax incentives to individuals and firms engaged in invention, research, development, marketing of a new 'product' or of an existing 'product' in new markets, or who are engaged in the supply of risk capital (this will require criteria for defining a risk venture).

The Government should change the emphasis of research and development in Canada away from a reliance on Government institutions which are not sufficiently concerned with the ultimate commercial exploitation of their work. Government should provide more funds to private enterprise to carry out research and especially development work where that work is part of a complete corporate program.

THE RESOURCE: PEOPLE

14. One of our top national priorities is the education and development of our people. But within Canada itself a situation persists that reinforces regional disparity; Central Canada tends to attract many of the best talents from the rest of the nation. People educated at the expense of their home regions tend to leave to go where the action is.

15. The same situation has developed between Canada and the American-directed economy. Every Canadian that works for a non-Canadian enterprise is to an extent working to diminish Canadian sovereignty. This problem cannot be legislated out of existence; it must be countered gradually by offering superior challenges and opportunities in Canada, in Canadian-owned organizations.

RECOMMENDATION 6: To attract people to work in Canada, on behalf of Canada, through positive incentives, should be one of the foremost concerns and priorities not only of a science policy but of the overall policy of the Government of Canada.

16. Continuing learning is a feature of our time; people are becoming more individualistic in their search for knowledge and skills.

RECOMMENDATION 7: Educational patterns are not set to meet particular industrial and economic conditions and objectives. A development policy must provide people with a broad range of opportunities for learning in both formal and informal environments.

17. We must foster truly multi-disciplinary groupings of skills and try to identify the stages of innovation which give the best return on the investment of the time and effort of the generalist and of the specialist.

18. We must be concerned with developing managerial and organizational capability, as well as scientific ability, to provide direction, cohesion, and stimulus to research and development efforts.

19. We believe that cultural diversity is a Canadian strength. Science Policy should capitalize on this strength by encouraging a multicultural as well as a multi-disciplinary dimension to Canadian endeavors.

THE MEANS: TOOLS, TECHNIQUES, AND ATTITUDES

20. The impact of the computer in our living and working environment is so large that it is changing the very nature of our work and attitudes.

21. The human effects of moving into the computer age are serious and sometimes tragic; closing a generation gap in the understanding and acceptance of the computer will not be a smooth operation. Science Policy should encourage processes for reconciliation among human resources caught up in what could be a destructive confrontation.

22. While there may be a case for policy objectives in terms of specific computer applications, we believe that the main priority should be to develop and maintain a national capability in how to relate to the computer.

RECOMMENDATION 8: The priority effort in the development of computer technology and capability should be directed toward understanding and improving man-machine interactive relationships and toward the use of the computer for process design and simulation.

These aspects are basic to progress in specific applications and are essential if we wish to merge the computer into our pattern of national development.

23. Canada's small population, faced by the challenges of a vast land, has developed solutions of a particular excellence in survey and exploration, resources utilization and management, environmental innovation and adaptation, communications, transportation, and distribution. Our main technological strengths are in these areas.

24. Because our financial and human resources are limited we have had to concentrate not only on achieving excellence in what we do, but on obtaining optimum solutions to our fundamental problems. We have had to develop a global "Systems", approach to problems.

RECOMMENDATION 9: The scope of Government assistance to the development of 'products' should be broadened. Looking beyond the product, which may have a market in its own right, to the context in which it will be used.

We must recognize that such products combine with human skills and with other elements to form a comprehensive service. The innovation is in all of this and not just in the product itself.

This broader frame of reference should be formally recognized by the Government in its program of incentives.

25. Consultants play a leading role in the management of innovation, in the development of Canadian skills, and in the export of Canadian goods and services.

26. The Canadian experience is a highly marketable commodity. Experience gained in Canada serves Consultants in marketing their services abroad. These services, the resulting exports of goods and equipment and, often, the creation abroad of Canadian-owned subsidiaries has been an important part of the Canadian effort to export.

27. An organization scaled to serve the Canadian market often finds itself at a disadvantage in world competition, where very large multi-national enterprises are in control. One answer to this challenge is the use of Consortia: consultants have been amongst the most successful proponents of this mode of operation.

RECOMMENDATION 10: In awarding contracts for major domestic projects, the Government should take into account the increased potential a firm or permanent consortium would have for the export sale of services based on the experience and record of accomplishment gained in Canada.

28. Canada is an innovative land and an innovative nation. We believe in our own destiny. Our proposals hold in the following points:

1. A commitment to Canada.
2. A sense of adventure.
3. The pursuit of excellence.
4. Building on strengths.
5. A world role.

1. INTRODUCTION

THE PURPOSE OF THIS BRIEF

1.1 The exhaustive review that your Committee is carrying out concerns every Canadian. The Policies that you will recommend and the actions that the Government will take on them will be of vital significance to the survival of Canada as an entity and to its continuation as a dynamic society in the post-industrial age. Your decision to go beyond an analysis of Government activities and to invite participation from all sectors is most significant.

1.2 You have received numerous briefs, many reviewing in considerable detail most aspects of a science policy. You have received recommendations, statistical data, suggestions for priorities, and lists of pet projects.
It is thus bold of us to make a submission at this late date since you probably expect from us, as engineers and consultants, quite detailed plans and programs.

1.3 Allow us rather to share some of our thoughts on the future development of our country and to express our philosophy as a professional organization, our profound interest in Canada and our concern for the quality of its institutions.

PREMISES

1.4 Certain assumptions are basic to one's thinking and have an influence on how one views policy. We have approached this brief with the following assumptions.
"Increasingly we live in a man-made world. Many of the parts of our environment started with science and engineering, but they have gone far beyond that, and have become essential to our work and home life."[7] The sciences will have profound effects on Canada as a nation and as a place to live and work.

As consultants we are closely involved with the sciences and with their technological offspring. As professionals we are concerned about the uses to which the sciences and technologies are put. "...we must find new ways to place new emphasis and attention on the human uses of technology... We can no longer afford technological breakthroughs that do not consider the costs imposed on the human system in which they operate."[6]

1.5 Positive policies of development are required if Canada is to survive as an entity that will provide a "milieu de vie" of its own for its people and maintain a distinctive role in the world community.

1.6 Canada, we know, is extraordinarily rich in natural resources. Yet, its fundamental asset remains its people. Any development policy must, of necessity, be concerned with people. Policies are not collections of 'things to do,' but the ground rules for creating an environment conducive to the full development of individuals by providing the stimulus and the challenge for accomplishment, and the opportunity to succeed.

1.7 We must excel in the endeavors we choose to pursue. André Laurendeau had a recurring preoccupation that the survival of French Canada depended on its achievement of excellence. Being a minority in numbers, parity with the rest of the population could only be attained through achieving superior standards of quality. This philosophy can readily be transposed to Canada's situation in relation to the United States and other nations.

Excellence that will meet the test of world competition requires specialization. We must build on our strengths. Our areas of strength are those where we have had to concentrate our efforts on issues of national survival:- exploration and survey, management and conservation of resources, environmental innovation and adaptation, and communications, transportation, and distribution.

1.8 Government has a role to play in setting priorities, establishing policies, and encouraging Canadian enterprise. But the main responsibility lies with individuals, and organizations in the private sector. The Government can encourage, stimulate and guide: it is not a substitute for the responsibility of all for national innovation, dynamism, and growth.

1.9 Canada's economic future rests on our ability to export products and services. Any development in Canada should take into account this vital consideration.

1.10 We must develop in Canada the creativity and the management capability to capitalize on innovation in any sector, rather than establish rigid priorities among sectors or create large research establishments to work on specific problem areas.

2. INNOVATION: THE AMERICAN IMPERATIVE

2.1 "....these innovative processes are an important part of the process that differentiates our rate of progress from that of the rest of the world."[8]

"This American process of making and exploiting discoveries and inventions has become a way of life for large industries as well as a career for exceptional individuals."[7]

2.2 Samuel Morse, a painter, invented and promoted the electric telegraph. Professor Alexander Graham Bell, a teacher of the deaf, invented the telephone. The Wright Brothers invented controlled flight in a bicycle shop. Edwin Land did with his camera what a highly skilled industry should have done. Ford started out under unpromising circumstances when he was 40 and gave us mass production and the first cheap car. Carlson, the typical garret experimenter, gave us Xerography.[7]

2.3 "America has a particularly glorious tradition of taking those prescient steps which supplant rather than solve the problems of the past."[7] This last quote is most significant.

RECOMMENDATION 1: Science Policy cannot be directed at the problems of yesterday or the technologies of today. To meet the challenges of tomorrow, it must concern itself with the process of development rather than with a set of specific problems.

The main thrust of a Canadian Science Policy should be toward understanding and stimulating the process of innovation.

2.4 The U.S. Imperative in innovation has resulted from the intelligent massing and use of industrial power based on these characteristics:-[3]

- the development of a scientific effort without parallel.
- the development of a powerful intelligence potential specifically attuned to new opportunities.
- an ability to obtain expansion capital by the generation of profits.

2.5 The contemporary business enterprise, in its most evolved form is multi-national. It recognizes no historical constraints on its endeavors; in its immediacy of information and its control of its own destiny it seeks to conquer distance and time to establish its own, corporate, version of immortality.

Its tools are the computer, telecommunications, and an improving understanding of human qualities and motivations:- taken in combination these tools give its management the ability to plan, control, and achieve great things.

In intent, if not yet entirely in fact, it is dedicated to an improved use of resources;- financial, natural, and human.

Planning is implicit in all its actions; to establish and to achieve objectives at all levels.

These characteristics are as much a State of Mind as a State of Size.[1]

RECOMMENDATION 2: Science Policy should support Canadian organizations that feature:

- ventures and services to improve the environment of man,
- high investment appeal,
- an innovative, opportunity-oriented approach.

3. THE NEED: INNOVATION

MAINTAINING THE INNOVATION ADVANTAGE

3.1 Canada, to continue its diversified industrial growth, must develop its innovative skills. As a nation we must be prepared to compete in the international marketplace, and to compete successfully we must adopt the attitude of a business enterprise.

"If a firm wishes to continue to exist it must be so managed as to insure a high level of profitability; otherwise it will disappear. Useful products and services and long-term profitability are the result of innovation; and profitability above the base 'fee-for-the-use-of-assets' level results only from the innovation advantage and disappears as soon as the innovation has become routine." [9]

Innovation is much broader than innovation in ideas or in basic discovery; it includes all the steps from idea to enterprise with particular emphasis on financing, production, and marketing.[9, 14] Breakthroughs in ideas generally come from the individual and not from the group. Breakthroughs in new products and markets likewise depend on entrepreneurial individuals who are motivated by the opportunity for profit and by an absolute confidence in their abilities to sell the ideas that others have put forward.

3.2 Because of this individualism that characterizes innovation, it is not a phenomenon that can be force-fed or scheduled. It arises spontaneously, but when it has germinated in a given instance it needs appropriate conditions in which to flourish. Thus, some criteria for a science policy:

3.3 Stimulate communication between inventors and innovators in ideas, and innovators in development, finance, marketing, manufacturing.

The individual, be he amateur or professional, should enjoy the freedom to express his ideas knowing that his patent and copyright rights will be fully assured. This will require simpler and more adequate patent and copyright protection backed by the full power of the Canadian Government giving priority attention to securing these rights in Canada, and especially in world markets.

3.4 Follow Through: innovation in ideas or discovery is only the first stage. Much more is required to cause a market impact. "Research and Development expenditures were by no means synonymous with innovation, representing less than 10% of the total innovative costs of a new product." [8] Canada's expenditures on innovative costs other than for basic research & development are seriously out of balance with the spread of expenditures needed for successful industrial impact.[14]

3.5 Encourage "Amateur" Invention: amateurs and professionals should be placed on the same footing for Government Tax incentives to innovation. This is particularly relevant to invention and discovery.

RECOMMENDATION 3: Science Policy should stimulate communication between innovators in ideas or invention, and innovators in finance, development, production, and marketing.

Science Policy should encourage simpler and more adequate world-wide patent and copyright protection for the individual backed by the full power of the Canadian Government.

Amateurs and professionals should be on the same basis for tax incentives to invention, discovery,and innovation.

There should be follow-through in innovation support or subsidy to cover all the aspects of innovation from ideas to market impact.

THE RANGE OF SKILLS NEEDED[10]

3.6 The industry growing out of a new technology changes as it grows. Its original research/model shop type of operation evolves into

something closer to production. The number of R & D people needed shrinks; instead the industry looks for production and applications engineers, quality control staff, marketing staff, etc. The nature of the challenge changes and people with different motivations and skills are needed as it moves from one phase to the next.

The total process of innovation that will carry an idea forward to develop a successful industry depends on the availability of this continuum of motivations and skills. If there are serious gaps in this industrial capability, then investment in innovation could prove to be a waste of funds.

RESEARCH AND DEVELOPMENT OBJECTIVES

3.7 The firm or organization engaged in research, development, or innovation, should have a well-defined purpose, a well-defined corporate strategy, and deliberate plans for harnessing the results of research and development to its own ends.

The employment of a deliberate planning approach to innovation is more important than the nature of the innovation, because it imposes a very pragmatic test of the worth of the innovation on the open market.

This suggests that National Goals are not a sufficient answer. National Goals can only be meaningful if the economy is strong enough to support effective programs. A continuing upwelling of innovation from the private sector that results in enterprises with high profitability remains a condition for development. National Goals will ensure that at least some of the innovative industry and energy will be directed to the solution of pressing national problems.

RECOMMENDATION 4: Government support for private research and development should be made conditional on the preparation of a plan that relates the roles of research and development to the other corporate functions.

INNOVATION AND RISK

3.8 Risk capital is needed if innovation is to succeed. Without risk capital, the viability of the individual or the smaller business as developer and promoter may prove transitory; from idea to failure, or from idea to absorption by a large enterprise. For Canada this has too often meant "Ideas in Exile," or the takeover of Canadian firms by U.S. capital.

Some submissions have suggested that the Government should provide risk capital, directly or indirectly. We believe that innovation in ideas by its very nature runs contrary to nearly every principle of objective investment; the time to return on investment may be long, and the route to success may be tortuous. Accordingly, we believe that the Government should not take a "review board" approach to decisions on apportioning risk capital, but act to encourage and stimulate risk and innovation.

RECOMMENDATION 5: The Government should provide tax incentives to individuals and firms engaged in invention, research, development, marketing of a new 'product' or of an existing 'product' in new markets, or who are engaged in the supply of risk capital (this will require criteria for defining a risk venture).

The Government should change the emphasis of research and development in Canada away from a reliance on Government institutions which are not sufficiently concerned with the ultimate commercial exploitation of their work. Government should provide more funds to private enterprise to carry out research and especially development work where that work is part of a complete corporate program.

CRITERIA OF TIME AND SCOPE

3.9 There have been very few "revolutionary inventions that change our lives drastically."[7] (e.g. internal combustion engine, telephone, the transistor, nuclear fission, antibiotics, insulin, the pill, etc). Accordingly, applied research today is not concerned in the main with expanding the number of scientific discoveries, but with exploring how industry can exploit discoveries in many ways.

Science Policy in establishing criteria for assessing the risks and the payoffs of a venture should recognize that the objectives of applied research and development are to shorten the time gap from fundamental discovery to industrial impact, and to broaden the dimensions of that impact. "Time to Impact," and "Scope of Impact," are fundamental, and crucial parameters.

4. THE RESOURCE: PEOPLE

HUMAN RESOURCES AND NATIONAL DEVELOPMENT

4.1 One of our top national priorities is the education of our people and the development of their skills. We expend much of our talents and a great deal of our financial resources on this. We do this because we believe each person has the right to opportunity and because our economic growth depends on it.

Education, training, and learning affect both the individual and the nation. The well-being of the individual is, we believe, more important than that of the nation. But we also believe that Canada offers advantages to the individual that differ in some respects from, and in total are superior to the climate of opportunity found in other countries. Accordingly, we believe that it is to the advantage of each Canadian as a person that Canada should continue to develop in its own way.

4.2 Within Canada itself there has persisted for many years a situation leading to the reinforcement of regional disparity; the industrialized cities of Central Canada have tended to attract many of the best talents from both Eastern and Western Canada. People educated and trained at the expense of their local and regional communities have tended to go where the action is.

The same situation has developed between Canada and the American - directed economy; too many Canadians, having grown up and been educated in Canada, have either moved to the United States or joined a non-Canadian owned business enterprise in Canada.

The key human resources developed and trained at great cost in time, money and skills are being harnessed by a competitor to reinforce the takeover of our industry and our resources. Every Canadian that works for a non-Canadian enterprise is to an extent working to diminish Canadian sovereignty.

Why do people choose to work for non-Canadian firms, or to emigrate to the United States? Because they find more and better challenges and opportunities to use their skills and to advance their individual careers.

There is no ready answer to this problem; it cannot be legislated out of existence. It must be countered gradually by offering superior challenges and superior opportunities in Canada, in Canadian-owned organizations.

RECOMMENDATION 6: To attract people to work in Canada, on behalf of Canada, through positive incentives, should be one of the foremost concerns and priorities not only of a science policy but of the overall policy of the Government of Canada.

SELF-DEVELOPMENT

4.3 The development of people is not something that needs to be forced; one of the features of our times is the explosive increase in the demand for adult education. But it is becoming more difficult to impose a pattern on this development; people are becoming more individualistic in their search for knowledge and skills and in their self-realization.

Continuing learning will have a particularly significant payoff to individuals, and to Canada as a nation.

RECOMMENDATION 7: Educational patterns are not set to meet particular industrial and economic conditions and objectives. A development policy must provide people with a broad range of opportunities for learning in both formal and informal environments.

MULTI-DISCIPLINARY INNOVATIONS

4.4 Many of the revolutionary discoveries in science have been made by persons who are new to the field; either fresh out of school, like the early quantum mechanicians, or having shifted from another field.[10]

Those who are well grounded in a given field tend to be bound by the patterns of thought that have served well for the treatment of past problems.

The newcomer comes to the new challenge with a different bag of tricks. He may be bound to patterns that worked in his old field, but these may be revolutionary patterns to the new one. Besides, the old patterns never can be applied exactly; they have to be adapted. And in the process of adaptation something entirely new sometimes emerges.

We must foster truly multi-disciplinary groupings of people and we must analyze the various ways a generalist can react with specialists, and with other generalists, in the group, and try to identify the stages of innovation where the use of the generalist is most required and which give the best return on the investment of his time and effort.

Obviously, one of the first areas where the gap between disciplines can be bridged is in the educational process: as has often been said, our separate and autonomous university "compartments" must give way to an educational experience that blends rather than separates. This effort at "mixing" specialist and generalist should continue beyond formal education with permanent encouragement of conferences and societies.

THE NEED FOR GENERALISTS

4.5 The Specialist and the Generalist are interdependent in today's complex world of inter-related problems and inter-related opportunities.

Generalists, people with a multi-disciplinary capability for conceptualization, design, and management, are an essential element in our national development.

Such people are always in short supply; yet, those that we have often find themselves engaged in a continuing struggle to put their capabilities to use. They have a communications problem because they are ahead of their time; that is their Raison d'Etre. It can be debated endlessly whether such people are born with a latent capability, or whether it evolves from their education and experience.

Regardless, they require a climate of opportunity in which to express their talents. Science policy should take cognizance of their existence and of the need for their abilities, and should consider how best to encourage their development and where best to use their abilities.

This also underlines the importance of developing not only scientific ability, but also managerial and organizational capability to provide direction, cohesion and stimulus to research and development efforts.

CULTURAL DIVERSITY

4.6 SNC is multi-cultural and bilingual; indeed with "new" and "old" Canadians from many nations, with its offices and operations spanning the Continent, it is in many ways a microcosm of Canadian society. This is not, of course, a unique phenomenon. But it is particularly significant in a professional organization where the "product" is necessarily the result of constant interaction between individuals. The ability of an organization to 'see' a problem from different perspectives, and to share insights so as to launch a concerted effort, is, we believe, an ability that Canadians are in a favored position to develop.

We enjoy, as Canadians and as consultants, the trust and acceptance of many nations. As a firm we are exercising a role as a bridge between languages and cultures. We are doing this mainly in the international field, but we believe the same role can and must be developed in Canada.

If we are right in our assumption that this cultural diversity is a Canadian strength, then science policy should capitalize on that strength by encouraging a multi-cultural as well as a multi-disciplinary dimension to Canadian endeavors.

5. THE MEANS: TOOLS, TECHNIQUES AND ORGANIZATION

THE COMPUTER: NEW TIMES, TOOLS, AND ATTITUDES

5.1 There is a major generation gap in the understanding of computers. The present generation of students, and recent graduates, have been 'living with the computer'. Too few of the senior managers and technical staff in the organization they will join share their perspective.

The emergence of Canadian society and industry into the computer age will largely depend on the missionary efforts and the replacement effects of the young.

But closing the computer gap will not be a smooth operation; major stresses and strains are already evident. The human effects are and will be of major consequence to many individuals and organizations. For economic reasons the gap must be closed. Accordingly, science policy should encourage the development of processes for reconciliation of important human resources caught up in a confrontation that can work irreparable harm to all.

5.2 "If your philosophy is one of living with the computer from day to day and having it an integral part of the way you think, the way you operate, the way you make decisions....you would adapt and change your ways, organize your information differently, follow new procedures for some things, use different terminologies..... new methods......The change in your working environment is of a bigger nature quantitatively than you anticipate and has a bigger qualitative effect upon much of how you work and think."[13]

"We have to consider other effects of these changes too.....man's emotional makeup, innate attitudes, perspective of himself and his relations and communication with others ... His way of working and thinking are going to change, and his perspectives and attitudes have to change to be consistent. We're talking about cultural shifts brought about by this technological age..."[13]

"changes in education, in the mix of talent and special knowledge required...in the relative costs of physical plant, equipment, and talent."[12]

THE MAN-MACHINE RELATIONSHIP

5.3 The more avant-garde uses of computers for direct intellectual extension[13] of man, deserves a special emphasis in science policy. These are something beyond the 'conventional' computer applications that compress time, extend the scope of control, and increase accuracy.

While there may well be a case for policy objectives, in terms of specific computer applications, we believe that the main priority in the computer area should be to develop and maintain a national capability in how to relate to the computer.

We believe the emphasis should be on developing a broad range of capabilities and facilities to explore this new world of man in relationship to machine.

The man-machine prospect is going to dramatically alter our future. If we, as a society, have adapted in pace with it we will be ready for that future and can help to shape it. If we are not ready for it we will be submerged by it.

The early digital computers were low-powered, and designed for scientific computations. Because of their limitations they were well-suited to provide "hands on" experience; the power of the computer, and its running costs, were not that much out of line with the power and costs of the individual user.

But as computers evolved in power and cost, the "closed shop" operation developed. The user now interacted with the computer operations staff instead of with the machine directly. This was more efficient in terms of machine use but it led to a man-machine coolness. This inhibited many people, who now occupy senior posts, from accepting the computer as a way of life.

Today the trend is to remote terminals, communicating with the computer through interactive software. This re-establishes the man-machine contact without diluting the effectiveness of the machine. Accordingly, we have a ready-made basis for indoctrinating many more people into the computer era.

Science policy should recognize this starting point, and should proceed from there to support more intensive, diversified, and sophisticated man-machine interactive facilities; as in computer-aided design, graphics, human intellect augmentation studies, information dialogue processes, etc.

5.4 The computer is a particularly powerful aid to process and systems simulation:- the exploration of design alternatives to develop a far more optimized result than would have been possible by non-computer methods. This allows the specialist designer to at last fully exploit his knowledge, experience, and capabilities.

This process or "product" design aspect deserves particular support. Science Policy should assist Canadian firms to build on our strengths; reinforcing areas of particular expertise by subsidizing the development of process design computer programs.

This prospective capability should be treated in the same way as a tangible product development and should be eligible for the same Government support programs. The export sales payoffs from such investments can be great.

RECOMMENDATION 8:

> The priority effort in the development of computer technology and capability should be directed toward understanding and improving man-machine interactive relationships and toward the use of the computer for process design and simulation.
>
> These aspects are basic to progress in specific applications and are essential if we wish to merge the computer into our pattern of national development.

CANADIAN PRAGMATISM AND THE SYSTEMS APPROACH

5.5 Canada is a vast country with a small population concentrated in a few pockets. We pay a heavy penalty for this in terms of per capita costs of the basic installations of civilization; communications, transportation, and distribution (of information, people, utilities, goods, and services).

Some of the areas of particular concern to us as Canadians, arising from our situation, are:

- Exploration and Survey; to determine what resources we have, and how best to use them.
- Management of resources; to preserve our heritage, and as a form of long-range planning for the benefit of our descendants.
- Environmental Technology; innovation and adaptation to enable human habitation and activities in a basically hostile physical environment.
- Communications, transportation, and distribution; to constitute a viable society and civilization and nation out of local and regional pockets. And to link together people, industries, resources, and markets to bring about growth.

Because these are areas of special interest to us we have tended to solutions of a particular excellence; these are our main technological strengths and they have proven to be of special interest to other nations facing similar problems.

And because our total human resources and capital are limited we have had to concentrate not only on excellence in our approaches, but on obtaining optimum solutions to our basic problems. We have had to develop what is now recognized as a "Systems" approach that provided a built-in assurance of quality; there is little slack available for alternatives if we fail the first time around.

BUILDING ON STRENGTHS

5.6 Reputation is the key to success; of an organization, and of a nation that relies on international markets. Reputation comes from strength of performance, and from strength of purpose.

Science policy should support measures that build on our strengths, and publicize our strengths

Because of our strengths Canadian consultants have been highly successful in designing, developing, and marketing a combination of instrumentation and human skills around the world. This has often resulted in the establishment in foreign countries, including the United States, of subsidiaries of Canadian-owned firms (particularly in surveying, mapping, exploration, resource development, pulp and paper and mining industries).

The Federal Government, through its Department of Industry and through other programs has provided assistance for the development of products and instrumentation. The scope of this assistance should now be broadened.

RECOMMENDATION 9: The scope of Government assistance to the development of 'products' should be broadened. Looking beyond the product, which may have a market in its own right, to the context in which it will be used.

We must recognize that such products combine with human skills and with other elements to form a comprehensive service. The innovation is in all of this and not just in the product itself.

This broader frame of reference should be formally recognized by the Government in its program of incentives.

(SNC, through its Metaltech subsidiary, has recently obtained P.A.I.T. support for the development of a new type of tensor strain gauge for rock mechanics work. Out intention is to use this as part of a package; the instrument, together with specialized human skills, and eventually a computer program for analysis of field data, should result in a comprehensive service that can be marketed in a variety of situations and countries).

CONSULTANTS AND NATIONAL GROWTH

5.7 Unlike much of "Canadian" industry, (and from what we read a fair proportion of the "Canadian" university establishment), the Canadian-based consultants are by and large Canadian in fact and in purpose. Consultants are concerned with the study, management, and re-shaping of the environment. Their role, and their responsibility, is to innovate and to serve as the planners and managers of innovation.

In answer to the question; where in the fields of science and technology in Canada should one look for leadership in the management of innovation on behalf of Canada, we suggest the consultants have so far shown the best return on investment.

5.8 Consulting organizations are excellent examples of "people industries"; developing and coordinating human mental capabilities and experience while providing wide scope for individual development and expression.

Canada as a nation has to export; one of our most successful exports is consulting services and, further, consulting services lead to export of goods and equipment.

"Inherent in the qualities of the consulting engineer is his readiness to meet new challenges. Foreign work, besides presenting a test of his technical capabilities will also require the consultant to face up to language problems and to exercise flexibility in dealing with local problems and customs".[11]

Economy of Scale is a powerful argument for large size. But this cannot, in most instances, be attained on the basis of servicing the Canadian market alone. World markets, and the United States market, must also be conquered.

For organizations from a nation with a relatively small population to service their own population and to compete successfully on the world scene, requires two often incompatible conditions:- small or medium size for national work, and very large size for international work.

5.9 One answer to this dilemma has been the organization of consortia; the most successful proponents of this mode of operation have been the consultants and this has strengthened individual and collaborative success.

In some instances these consortia have become permanent business entities, drawing talents from their parent firms (who otherwise are in competition), and following an independent course. An outstanding example of such an arrangement is CANATOM in which SNC has equal shares with Montreal Engineering and Shawinigan Engineering. We three are in active competition in other areas, but we have come together in this instance to pool our nuclear experience and capability. CANATOM represents on world markets all of Canada's professional nuclear power design capability. We believe that such consortia should be launched only where there is an intention of a continuing collaboration in a particular field. A consortium should represent for Canada a combination of skills marketable in the face of the best of world competition.

RECOMMENDATION 10: In awarding contracts for major domestic projects, the Government should take into account the increased potential a firm or permanent consortium would have for the export sale of services based on the experience and record of accomplishment gained in Canada.

6. FINAL REMARKS

What we have tried to say in the foregoing paragraphs can perhaps be summarized in a very few words. Canada has never suffered from a shortage of innovative ideas. We attract them because of the very nature of our land and of our nation.

But too often, as individuals, as organizations or as Government we lack the confidence required to develop the wealth we have inherited or attracted.

A development policy for Canada (and a science policy is a development policy) begins with a belief in our own destiny. Our own purpose, and our proposals, hold in the following propositions:

1. A commitment to Canada.
2. A sense of adventure.
3. The pursuit of excellence.
4. Building on strengths.
5. A world role.

REFERENCES

1. "Petite ou Grande Entreprise: Co-existence ou Destruction"
Bulletin Mensuel Vol. 44 Numéro 4, Avril 1969.
Banque Canadienne Nationale.

2. "Managing Technological Innovation"
D.R. Schoen
Harvard Business Review - May-June 1969.

3. "Le Défi Américain" - J-J Servan-Schreiber

4. "Ideas in Exile" - J.J. Brown, McLellan & Stewart, 1967

5. "Technology Transfer and Industrial Innovation"
Sumner Myers, National Planning Association "Looking Ahead"
Feb. 1967.

6. H.W. Johnson, President of M.I.T.
Speech to Swiss Federal Institute of Tecynology,
reported in Research/Development magazine, Feb. 1969.

7. "Exploiting Research: The Fruitful course of Action".
J.R. Pierce. Bell Telephone Laboratories.
"Engineering Opportunities" magazine. March 1969.

8. "Key to Innovation: Loosening the Reins on the Backyard Inventor."
New York Times May 14, 1967.
describing the report to the U.S. Dept. of Commerce by the group
chaired by R.A. Charpie, assessing the problems and needs of
inventors.

9. "How to Manage R & D Innovation"
Dr. Patrick E. Haggerty, President: Texas Instruments.
Reported in Research/Development magazine for August 1965.

10. "Mobility and Specialization" M.C. Pease
The Microwave Journal Nov 1965.

11. "Engineering Intelligence Network pin-points Overseas Opportunities"
M. M. W. Smith "Canadian Consulting Engineer" Sept 1966.

12. "A Change in Time, Tools, and Techniques today as the basis of
trends to Tomorrow." Editorial by C.J. Mosbacher
Research /Development magazine August 1968 ("R & D Tomorrow" issue)

13. "Augmenting your Intellect" interview with D.C. Engelbart, head of
Stanford Research Institute's Augmented Humal Intellect Improvement
Center.
Research/Development magazine August 1968.

14. Address by Dr. R. Gaudry, Rector: University of Montreal and
Vice-Chairman, Science Council of Canada,
June 8-12, 1969 to Canadian Nuclear Association.

APPENDIX

1. THE COMPANY

SNC ENTERPRISES LTD. is a professional organization of consultants offering complete and integrated engineering services for optimizing the capital investment projects of its clients.

The Group has a staff of over five hundred employees including 200 professionals (Engineers, Architects, Economists and Planners).

2. HISTORY

The organization was founded in 1911 by the late Arthur Surveyer, one of Canada's foremost engineers. In 1937 he associated with Mr. Emil Nenniger and Mr. J. Georges Chênevert. By 1961 the partnership was extended to six additional senior members of the firm. In 1966, SNC was registered as a Company, extending shareholders' participation to some fifty senior employees. There are to-day over 80 shareholders, all employees of the company.

3. COMPANIES OF THE SNC GROUP

SNC Enterprises Ltd.	A holding and operating company for the group.

Fully owned companies:

Surveyer, Nenniger & Chênevert Inc.	The main company of the group. Offers conceptual, planning, design and construction management services in the following fields: Manufacturing Industries Mining and Metallurgy Chemical Plants Hydroelectric and Hydraulic Thermal and Nuclear Plants Municipal Services Public Works Commercial Buildings Institutional Buildings

Sorès Inc.	Scientifically – oriented Management Consultants. – Social and economic research – Feasibility and marketing studies – Operations research – CPM/PERT programming
Terratech Ltd.	Soils engineering and investigation Materials testing laboratory
SNC Computation Ltd.	Computer applications, information systems, commercial data processing
Pentagon Construction Corporation	Construction
Metaltech Inspection Ltd.	Inspection, evaluation and technical investigations.
QIDR Inc.	Industrial development, plant location and marketing studies.
G.S. Turcotte & Associés Ltée.	Engineering services: institutional and commercial
Reprotech Ltd.	Printing and reproduction

Associated Companies

T. Ingledow & Associates Ltd.	Engineering services: hydropower and hydraulic, natural resources development, planning, transmission lines.
Demers, Gordon, Baby Ltd.	Systems Consultants
SNC Filer Ltd.	Engineering services: industrial and commercial.

CANATOM	Nuclear power development (jointly with Montreal Engineering Co. and Shawinigan Engineering Co.)

Group Head Offices are in Montreal with other offices in Vancouver, Hamilton, Quebec City, Sept Iles and London (England).

4. AREAS OF WORK

Work has been performed in eight of the ten provinces of Canada, the Arctic and Sub-Arctic and in the following countries:-

Abu Dhabi	Morocco
Algeria	Mongolia
Australia	New Zealand
Belgium	Nigeria
Ceylon	Pakistan
Columbia	Peru
Dahomey	Philippines
Ecuador	Saudi Arabia
Germany	Spain
Ghana	Togo
Greece	Turkey
India	United States
Jamaica	Zambia
Libya	

5. EDUCATIONAL ACHIEVEMENT

The S.N.C. group has an extensive program of personnel development including in-house courses and lectures, financial assistance for full-time or part-time attendance at Universities and a full two-year scholarship awarded by the firm each year to provide opportunity for post-graduate education.

6. DIRECTORS OF SNC ENTERPRISES, LTD.

C.A. Dagenais,	Eng., Montreal, President and Chief Executive Officer
E.W.J. Turcke,	Eng., Montreal, Vice President and Chief Engineer
J. Hahn,	Eng., Montreal, Vice President, Development
R.J. Balfour	Eng., Montreal and Vancouver, Vice President, Construction
G.A. Beaudin,	C.A., Montreal, Vice President, Finance
M. Valois,	M. Comm., Montreal, Secretary
A. Anctil	Eng., Montreal
W.A.H. Filer	Eng., Hamilton
R. Filiatrault	Eng., Montreal
P. Fortier	Eng., Montreal
J.P. Gourdeau,	Eng., Montreal
R.J. Griesbach,	Eng., Montreal
T. Ingledow,	Eng., Vancouver
D.D. Mears	Eng., Vancouver
C. Senneville	Eng., Montreal
R.A. Surveyer,	Eng., Montreal

APPENDIX 192

ONTARIO

ONTARIO DEPARTMENT OF TRADE AND DEVELOPMENT

BRIEF

TO THE

SPECIAL SENATE COMMITTEE

ON

SCIENCE POLICY

MARCH 1969

I N D E X

INTRODUCTION:

1. THE PURPOSE OF THIS BRIEF IS TO RECOMMEND THE ESTABLISHMENT OF FEDERAL RESEARCH AND DEVELOPMENT PROGRAMS, WHICH WILL ENABLE THE EFFECTIVE EXPLOITATION OF SCIENCE AND TECHNOLOGY BY INDUSTRY TO THE BENEFIT OF ALL CANADIANS.

* * *

2. THE DEVELOPMENT AND CO-ORDINATION OF RESEARCH POLICY IN CANADA IS MORE COMPLEX THAN IN OTHER NATIONS BECAUSE OF FEDERAL/PROVINCIAL GOVERNMENT STRUCTURES AND RESPONSIBILITIES. IT IS GENERALLY ACCEPTED THAT THE FEDERAL GOVERNMENT IS RESPONSIBLE FOR BROAD NATIONAL SCIENTIFIC RESEARCH POLICY. THUS, THE PROVINCIAL GOVERNMENTS' SCIENCE POLICIES ARE COMPLEMENTARY TO NATIONAL POLICY, WITH EACH PROVINCE DETERMINING ITS OWN NEEDS IN AREAS NOT COMPLETELY COVERED BY THE NATIONAL POLICY, OR SUPPORTING ACTIONS TO ACHIEVE NATIONAL GOALS THAT REQUIRE PROVINCIAL PARTICIPATION.

3. THE ABSENCE OF A CLEAR-CUT NATIONAL SCIENCE POLICY ON INDUSTRIAL RESEARCH LIMITS PROVINCIAL GOVERNMENTS IN ESTABLISHING WELL-THOUGHT-OUT, LONG-RANGE SUPPLEMENTAL PROGRAMS. HENCE, UNDER PRESENT CIRCUMSTANCES THE PROVINCIAL GOVERNMENT DEPARTMENTS HAVE NO ALTERNATIVE

BUT TO INSTITUTE SHORT-RANGE POLICIES BASED ON OBVIOUS NEEDS IN THE PROVINCE WITHIN THE AREA OF THEIR JURISDICTION. THIS IS THE PROBLEM OF THE ONTARIO DEPARTMENT OF TRADE AND DEVELOPMENT.

INDUSTRIAL RESEARCH:

4. ONE OF THE PRIME RESPONSIBILITIES OF THE DEPARTMENT OF TRADE AND DEVELOPMENT IS TO STIMULATE ECONOMIC GROWTH IN ONTARIO BY ENCOURAGING AND ASSISTING THE DEVELOPMENT OF INDUSTRY AND CERTAIN OTHER RESOURCES IN THE PROVINCE. SINCE APPLIED RESEARCH IN THE PHYSICAL SCIENCES IS A DYNAMIC MEANS FOR ACCELERATING ECONOMIC GROWTH, IT FOLLOWS THAT THE DEPARTMENT OF TRADE AND DEVELOPMENT IS CONCERNED WITH THE LEVEL, SCOPE, GENERAL BALANCE, AND PERFORMANCE OF INDUSTRIAL RESEARCH UNDERTAKEN IN THE PROVINCE. APPLIED RESEARCH AND DEVELOPMENT IN THE INDUSTRIAL FIELD IS OUR PRESENT ESSENTIAL AREA OF INTEREST.

(a) IMPORTANCE:

5. THE IMPORTANCE OF RESEARCH AND DEVELOPMENT TO THE ECONOMIC GROWTH OF AN INDUSTRIALIZED COMMUNITY IS DIFFICULT TO MEASURE IN PRECISE TERMS, BUT ECONOMISTS*

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*SOLOW, R., "TECHNICAL CHANGE AND PRODUCTION FUNCTION", REVIEW OF ECONOMICS AND STATISTICS, VOL. 39.
KENDRICK, J.W., "PRODUCTIVITY TRENDS IN THE UNITED STATES", PRINCETON UNIVERSITY PRESS, PRINCETON, 1961.
DENISON, E.F., "SOURCES OF ECONOMIC GROWTH IN THE UNITED STATES, 1962".

HAVE SHOWN TECHNOLOGICAL CHANGE TO HAVE BEEN A MAJOR FACTOR IN THE GREAT INCREASE IN OUTPUT PER UNIT OF LABOUR AND CAPITAL THAT HAS TAKEN PLACE IN MOST INDUSTRIALIZED NATIONS SINCE 1900. IT IS INDICATED THAT ONLY ABOUT 20% OF THE GAIN IN LABOUR PRODUCTIVITY HAS BEEN DERIVED FROM THE MORE INTENSIVE USE OF CAPITAL, WHILE ABOUT 80% HAS BEEN DUE TO THE USE OF NEW TECHNOLOGIES AND THE GREATER COMPETENCE OF WORKERS AND MANAGERS.

6. THE ECONOMIC COUNCIL OF CANADA STATED THAT THE DOMINANT CHALLENGE OF CANADA'S MEDIUM-TERM ECONOMIC HORIZON WILL BE TO PROVIDE RAPIDLY EXPANDING EMPLOYMENT OPPORTUNITIES IN THE FACE OF INCREASING EFFICIENCY OF OPERATION. ONE OF THE MOST IMPORTANT AREAS THROUGH WHICH THIS CHALLENGE CAN BE MET IS SECONDARY MANUFACTURING. ONTARIO WITH SOME 13,000 MANUFACTURING COMPANIES, PRODUCING OVER 50% OF CANADA'S MANUFACTURED GOODS, EXPORTING NEARLY 80% OF CANADA'S FULLY MANUFACTURED PRODUCTS, AND EMPLOYING OVER 45% OF CANADA'S MANUFACTURING LABOUR FORCE, IS PARTICULARLY WELL SUITED TO MEET THIS CHALLENGE.

7. TO MEET THIS CHALLENGE OF INCREASING EFFICIENCY THROUGH THE EXPLOITATION OF TECHNOLOGY AND ASSURE A MAJOR EXPANSION IN SECONDARY MANUFACTURING WILL REQUIRE FOREIGN AND DOMESTIC FIRMS TO EXPAND OR ESTABLISH

RESEARCH AND DEVELOPMENT FACILITIES IN CANADA. TO ENCOURAGE THOSE COMPANIES TO INVEST CAPITAL IN RESEARCH AND DEVELOPMENT, THERE MUST BE AVAILABLE TO THEM RESEARCH AND DEVELOPMENT PROGRAMS AND ACTIVITIES DESIGNED TO MEET THEIR SPECIFIC NEEDS.

(b). <u>INDUSTRY'S RESEARCH AND DEVELOPMENT NEEDS</u>:

8. ONTARIO INDUSTRIAL FIRMS MAY BE CLASSIFIED IN THREE CATEGORIES:

(1) THOSE COMPANIES LARGE ENOUGH TO SUPPORT A RESEARCH FACILITY OF THEIR OWN - 5%;

(2) THOSE COMPANIES WITH A RESEARCH PROGRAM, BUT UNABLE TO AFFORD TO SET-UP THEIR OWN PRIVATE FACILITY - 15% TO 20%;

(3) THOSE COMPANIES THAT CANNOT AFFORD TO SUPPORT ANY RESEARCH AND DEVELOPMENT - 75% TO 80%.

9. AT THIS TIME, THE PROVINCE MUST GIVE PARTICULAR ATTENTION TO THE SECOND GROUP--THOSE COMPANIES THAT CAN SUPPORT RESEARCH AND DEVELOPMENT PROGRAMS. THIS GROUP COMPRISES MOST OF THE ESTABLISHED AND GROWING COMPANIES ENGAGED IN SECONDARY MANUFACTURING: AND IT IS FROM THESE COMPANIES THAT ONTARIO CAN EXPECT THE

GREATEST GROWTH. THESE ARE THE COMPANIES, HOWEVER, THAT OFTEN IN THE PAST HAVE BEEN UNABLE TO MAKE USE OF RESEARCH AND DEVELOPMENT INCENTIVES PROVIDED BY THE FEDERAL GOVERNMENT.

(c) PRESENT ONTARIO GOVERNMENT SUPPORT:

IN THE BROAD SENSE, THE ONTARIO GOVERNMENT IS ALREADY CONTRIBUTING TO THE RESEARCH AND DEVELOPMENT NEEDS OF ALL THREE CATEGORIES. THE SHERIDAN PARK RESEARCH COMMUNITY LOOKS AFTER THE NEEDS OF THE LARGE COMPANIES THAT CAN SUPPORT THEIR OWN RESEARCH FACILITIES. THROUGH CONTRACT RESEARCH, THE INDEPENDENT AND NON-PROFIT ONTARIO RESEARCH FOUNDATION LOOKS AFTER THE NEEDS OF THE MEDIUM-SIZED COMPANIES THAT CAN SUPPORT RESEARCH AND DEVELOPMENT PROGRAMS, BUT NOT THEIR OWN RESEARCH FACILITIES. ALSO, THE ONTARIO RESEARCH FOUNDATION ASSISTS SMALL ONTARIO COMPANIES (CATEGORY-3) BY PROVIDING TECHNICAL INFORMATION AND FIELD SERVICES, WITHOUT CHARGE, THROUGH GRANTS RECEIVED FROM THE ONTARIO GOVERNMENT AND THE NATIONAL RESEARCH COUNCIL.

SHERIDAN PARK RESEARCH COMMUNITY WAS ESTABLISHED FOR PRODUCTION-ORIENTED RESEARCH ONLY. IT WAS AN EXPERIMENT THAT HAS SUCCESSFULLY BUILT UP INDUSTRIAL RESEARCH AND DEVELOPMENT POTENTIAL IN ONTARIO. SHERIDAN PARK PROVIDES AN OPPORTUNITY FOR COMPANIES TO LOCATE

THEIR RESEARCH AND DEVELOPMENT FACILITIES IN ONE CLOSELY KNIT COMMUNITY FOR THEIR MUTUAL ADVANTAGE. THE SITE WAS SELECTED TO ENSURE MAXIMUM CONVENIENCE WITH REGARD TO PROXIMITY TO UNIVERSITIES, INDUSTRY CONCENTRATIONS, AND SO FORTH. TO DATE, THE PROVINCE, THROUGH THE SHERIDAN PARK CORPORATION, HAS INVESTED SOME $3 MILLION IN DEVELOPING THE SHERIDAN PARK RESEARCH COMMUNITY.

WITH THE ONTARIO RESEARCH FOUNDATION AS THE "NUCLEUS" OF SHERIDAN PARK, EMPHASIS HAS BEEN ADDED TO ONTARIO RESEARCH FOUNDATION'S POTENTIAL FOR SERVING THE SCIENTIFIC AND TECHNOLOGICAL NEEDS OF ALL INDUSTRY IN THE PROVINCE. IN THIS REGARD, THE ONTARIO GOVERNMENT SUPPORTS THE ONTARIO RESEARCH FOUNDATION THROUGH ANNUAL GRANTS ($1,490,000 FOR THE FISCAL YEAR 1969-70). THE MAJOR PORTION OF THIS GRANT, OVER $1 MILLION FOR THE FISCAL YEAR 1969-70, IS ON A DOLLAR-TO-DOLLAR RATIO WITH INCOME RECEIVED FROM CANADIAN CORPORATIONS FOR CONTRACT RESEARCH UNDERTAKEN BY THE ONTARIO RESEARCH FOUNDATION. THE GRANT ALSO PROVIDES $200,000 A YEAR, FOR A FIVE-YEAR PERIOD, FOR MODERNIZING SCIENTIFIC EQUIPMENT. THE FIRST SUCH GRANT WAS MADE IN THE FISCAL YEAR 1968-69. IN ADDITION, THE PROVINCE PROVIDED $5,255,000 TO THE ONTARIO RESEARCH FOUNDATION TO ASSIST ITS EXPANSION AND RELOCATION TO SHERIDAN PARK.

13. THE RESEARCH COMMUNITY, THROUGH ITS ASSOCIATION OF MEMBER COMPANIES (CALLED THE SHERIDAN PARK ASSOCIATION), IS NOW ENGAGED IN FURTHER DEVELOPMENTS OF MUTUAL BENEFIT. ONE PROJECT IS TO ESTABLISH AN OUTLET IN THE COMMUNITY FOR A NATIONAL INFORMATION STORAGE AND RETRIEVAL SYSTEM. THE STORAGE AND RETRIEVAL OF TECHNICAL INFORMATION ON A NATIONAL BASIS POSES A COMPLEX PROBLEM FOR THE FEDERAL AUTHORITIES, AND ITS SOLUTION WILL BE EXPENSIVE. AT THIS TIME, THE SCIENCE COUNCIL AND THE NATIONAL RESEARCH COUNCIL HAVE INDICATED THEY ARE IN FAVOUR OF ESTABLISHING AN OUTLET AT SHERIDAN PARK FOR ONTARIO INDUSTRY ON AN EXPERIMENTAL BASIS. WE HEARTILY ENDORSE THIS PROPOSAL.

14. ANOTHER PROJECT AT SHERIDAN PARK IS THE DEVELOPMENT OF A SCIENCE CONFERENCE CENTRE. THE ONTARIO GOVERNMENT HAS ALREADY PROVIDED SPACE AND THE SHERIDAN PARK ASSOCIATION HAS UNDERTAKEN TO MANAGE THE CENTRE AND TO PAY ITS OPERATING EXPENSES. CONFRENCES HELD AT THIS CENTRE WILL EMPHASIZE THE APPLIED ASPECTS OF RESEARCH RATHER THAN THE PURE ASPECTS, AND CONFERENCES WILL BE ORIENTED TO ATTRACT PARTICIPATION BY INDUSTRY AND UNIVERSITIES FROM THE WHOLE SOUTHERN ONTARIO REGION.

RECOMMENDATIONS:

15. THE CREATION OF A FAVOURABLE NATIONAL CLIMATE FOR INDUSTRIAL INNOVATION, TO ENSURE RAPID AND EFFECTIVE EXPLOITATION OF SCIENTIFIC AND TECHNOLOGICAL ADVANCES IS A PRIORITY OBJECTIVE.

16. WE FEEL THAT IMPLEMENTATION OF THE FOLLOWING RECOMMENDATIONS REGARDING RESEARCH AND DEVELOPMENT PROGRAMS WILL PLAY A MAJOR ROLE IN ACCELERATING CANADIAN ECONOMIC DEVELOPMENT, RESULTING IN: MORE JOBS, INCREASED EXPORTS, NEW PRODUCTS AND PROCESSES, AND ENHANCED LIVING STANDARDS FOR ALL CANADIANS.

(1) WITH REGARD TO INDUSTRIAL RESEARCH AND DEVELOPMENT INCENTIVES, TWO THINGS ARE NECESSARY. FIRST, THERE MUST BE SIMPLE GUIDLINES AS TO WHAT CONSTITUTES RESEARCH AND WHAT CONSTITUTES DEVELOPMENT; AND SECOND, INCENTIVE PROGRAMS MUST BE ESTABLISHED ALONG LIBERAL RATHER THAN RESTRICTIVE LINES.

(2) GOVERNMENT ASSISTANCE SHOULD BE IN THE FORM OF STATUTORY TAX ALLOWANCES AND CREDITS. THESE SHOULD BE ON AN EQUITABLE BASIS, READILY AVAILABLE TO COMPANIES OF ALL SIZES, SO THAT COMPANIES CAN UNDERTAKE RESEARCH AND PRODUCT DEVELOPMENT ACTIVITIES AS A NORMAL PART OF THEIR BUSINESS OPERATIONS.

(3) SUPPLEMENTARY GRANTS SHOULD BE AVAILABLE TO COMPANIES FOR SPECIFIC COMPANY RESEARCH AND DEVELOPMENT PROJECTS, THEREBY ASSISTING THESE COMPANIES TO REMAIN COMPETITIVE IN NATIONAL AND INTERNATIONAL MARKETS.

(4) GOVERNMENT CONTRACTS AND SUPPLEMENTARY GRANTS SHOULD BE AVAILABLE TO COMPANIES FOR RESEARCH AND DEVELOPMENT PROJECTS IN THOSE AREAS DEEMED BY THE FEDERAL GOVERNMENT TO HAVE A HIGH PRIORITY.

(5) FEDERAL RESEARCH AND DEVELOPMENT PROGRAMS MUST BE VIGOROUSLY PROMOTED SO THAT INDUSTRY, BOTH DOMESTIC AND FOREIGN, IS CONVINCED OF THE ADVANTAGES OF CARRYING OUT RESEARCH AND DEVELOPMENT IN CANADA.

17. IF THE FEDERAL GOVERNMENT ADOPTS OUR RECOMMENDATIONS, COMPANIES NOW IN CANADA, OR COMPANIES LOCATING IN CANADA IN THE FUTURE WILL BE:

(a) BETTER ABLE TO DETERMINE AND MEET THEIR OWN SHORT-TERM AND LONG-TERM RESEARCH AND DEVELOPMENT REQUIREMENTS.

(b) BETTER ABLE TO MEET THEIR RESPONSIBILITY TO THE NATIONAL INTEREST.

APPENDIX 193

Brief Submitted to the

SPECIAL COMMITTEE ON SCIENCE POLICY

of the

Senate of Canada

By the

CANADIAN PUBLIC HEALTH ASSOCIATION

June 18, 1969.

Canadian Public Health Association,
1255 Yonge Street,
Toronto 7, Ontario.

Brief to the Senate Special Committee on Science Policy

by the

Canadian Public Health Association

CONTENTS

SUMMARY OF MAIN CONCLUSIONS AND RECOMMENDATIONS

Broad Principles

1. The Association recommends:

   that the science policy of the Government of Canada, insofar as health is concerned, recognize and be based on a comprehensive modern concept of health, health services, and their objectives. (para. 25)

2. The Association believes:

   that to the traditional mainly preventive aspects of public health which involve communicable disease control, environmental sanitation, and health promotion through education and demonstration especially directed to mothers, infants, and children, there is now added a concern for the delivery of the total spectrum of personal care services to the individual in need of them. (para. 26)

3. The Association suggests:

   that the intrinsic value of these concepts in providing objectives and directions for decision-making should predominate over administrative considerations if the services are to be effective in achieving the desired goals. (para. 26)

Government Policy and Organization

4. The Association recommends:

   that the science policy of the Federal Government recognize its essential role in the health field, not only in terms of financial support, but especially in relation to the intra-mural research of the Department of National Health and Welfare which should mainly be of a developmental, operational and evaluative nature. (para. 27)

5. The Association is of the opinion:

   that the present structure of federal government financial support for research is reasonably comprehensive and adequate. (para. 28)

6. The Association recommends:

that there not be an undue emphasis in financial terms on clinical research to the possible neglect or disadvantage of perhaps less glamorous research of the developmental and evaluative kind. (para. 28)

7. The Association is of the opinion:

that the increased needs for sufficient numbers of adequately trained public health personnel call for somewhat more financial support than is presently available. (para. 29)

8. The Association believes:

that the efforts of government agencies in these areas will be strengthened by ensuring the viability of appropriate professional and voluntary agencies to present a non-governmental point of view. (para. 30)

and proposes:

that this support be directed to maintaining an independent capability for service operations of a demonstration or experimental type and for research projects. (para. 30)

Priorities

9. The Association recommends:

that demonstration projects should have evaluative research included if they are to serve their intended purpose. (para. 31)

10. and recommends further:

that demonstration projects and operational studies are needed in respect to the following:

i) alternative patterns of health services organization;

ii) alternative patterns of health practice;

iii) the use of auxiliaries and aides of various types;

iv) analyses of the cost-benefit type. (para. 31)

11. The Association believes:

that the needs for epidemiological and other research in such priority areas as infant mortality, cancer, accidents, and mental illness are virtually self-evident but need to be reiterated. (para. 32)

12. and is of the opinion:

that the communicable diseases require attention from the standpoint of:

- possible eradication of some long time problems;
- the more effective treatment of the venereal disease problem;
- intensified immunization programs in Canada. (para. 32)

13. The Association considers:

that regardless of the possible advantages of having certain environmental measurements made by other agencies, it is imperative that the assessment of health effects be the responsibility of health agencies alone. (para. 33)

BRIEF TO THE SENATE SPECIAL COMMITTEE ON SCIENCE POLICY

By The

CANADIAN PUBLIC HEALTH ASSOCIATION

THE ASSOCIATION - NATURE, OBJECTIVES, ACTIVITIES

Nature of the Organization

1. The Canadian Public Health Association, organized in 1910, has had an important influence on public health legislation in Canada and in all matters relating to those engaged in public health service. As the senior professional body in the field of public health, it has been the parent of several national organizations in specialized fields such as venereal disease control, mental health, child hygiene, vital statistics, and public health laboratory work. Through the years it has become a national organization with branches extending to all ten provinces. The nine provincial public health associations or affiliated societies are: the C.P.H.A. British Columbia Branch, the C.P.H.A. Alberta Division, the C.P.H.A. Saskatchewan Branch, the Manitoba Public Health Association, the Ontario Public Health Association, La Société d'hygiène et de Médecine Préventive de la Province de Québec, the C.P.H.A. New Brunswick-Prince Edward Island Branch, the C.P.H.A. Nova Scotia Branch, and the C.P.H.A. Newfoundland-Labrador Branch.

2. The Association functions through an Executive Committee and an Executive Council with annual meetings, including scientific sessions, held throughout Canada at various centres. The headquarters office and small staff are located in Toronto. The structure of committees and sections is presently under review but they have operated in such program and professional areas as: Public Health Practice, Recruitment of Public Health Personnel, School Health, Dental Health, Environmental Health, Maternal and Child Health, Health Education, Nutrition, Public Health Nursing, Laboratories, Vital and Health Statistics, and Research. The annual budget is of the order of $100,000, with revenues mainly from members' fees, journal subscriptions and advertising, fees for consultant services, grants from the Department of National Health and Welfare for research and services, and grants from the provincial health departments for services. During 1968-69 the W. K. Kellogg Foundation provided a grant of $45,000 for a period of four years, and the Canadian Life Insurance Association a grant of $25,000 for a three-year period.

Objectives

3. The objectives of the Association are stated in the revised Charter of 1960 as follows:

"The objects of the Association shall be the development and diffusion throughout Canada of the knowledge of public health and preventive medicine and all other matters and things appertaining thereto or connected therewith."

Membership

4. Membership in the Association includes physicians, dentists, veterinarians, engineers, laboratory scientists, nurses, health services administrators, health educators, public health inspectors, social scientists, statisticians, and others. Provision has been made this year to open the Association to interested members of the general public. Membership in the Association has more than doubled during the past 15 years increasing from 1,144 members in 1954 to 3,047 in 1968. During this period, growth has been erratic with an increase of 625 members from 1959 to 1960; the peak of 3,047 members was reached in 1968.

5. From available membership records it is not possible to derive accurate information about the professional qualifications of members. The title "doctor" is used by physicians, dentists, veterinarians, and a variety of Ph.D.'s. Approximately 48 percent of members are nurses; 31 percent physicians; 15 percent public health inspectors; the remainder being health educators, dentists, veterinarians, and others.

6. Although the Canadian Public Health Association is a national professional health organization of all the disciplines concerned with the health of the people of Canada, its membership represents only a fraction of public health workers. Information from several sources confirms that there is a large potential group from which an increased membership in the Association might be drawn.

Activities and Services

7. The Association has initiated studies of its own operations, the most notable of which was the study in 1957, by a special committee, under the chairmanship of Dr. K. C. Charron and composed of Drs. W.G. Brown, J. Gilbert, G.W.O. Moss, and W. Mosley, "to study the needs of the Association and find ways and means of meeting these needs." This valuable study resulted in the amendments to the Act of Incorporation (Charter) of 1960, redefined the objects of the Association, and made possible the revisions of the by-laws in 1964, 1966, and 1967.

8. The Association in 1967 established a Commission to undertake a comprehensive review of the role of the Association and a study of its aims, objectives, structure, organization and operation. The recommendations of this Commission, which consisted of Dr. Robin F. Badgley, Dr. M.R. Elliott, and Miss Jean C. Leask, were received and published this year and implementation action is already under way.

9. The activities of the Association have included the preparation of policy statements and standards, personnel matters, co-ordination responsibility, the publication of a journal, the operation of a consultant advisory service, and research. These activities are briefly described in the following paragraphs.

Policy Statements and Standards

10. The Association has issued policy statements on fluoridation, pesticides, accident prevention, immunization, cigarette smoking and health, metabolic mental retardate case finding, salmonellosis, and rheumatic fever prophylaxis. Other areas of concern to public health workers are being constantly studied. The Association has collaborated with the Department of National Health and Welfare in the preparation, by joint committees, of Canadian Drinking Water Standards and Objectives - 1968.

Personnel - Functions, Qualifications, Training

11. The Association has been concerned with studies of, and has periodically published statements on, the functions, qualifications, and job specifications for public health workers of various kinds. It has recently published a statement of the functions and qualifications of public health nurses. The Association has also been concerned with the training and certification of public health physicians. Reports on the recruitment of public health personnel, and on a study of the role and training of public health inspectors have been completed this year.

12. The Association has played an active role in the continuing professional education of its members through sponsorship of scientific sessions at provincial and national meetings, through publication of the Journal, and in-service training of inspectors. Since 1935 the Association has been providing a correspondence course for public health inspectors. The basic text for this course has been another Association publication "A Manual for Public Health Inspectors". The Association also acts as the certifying body for all public health inspectors in Canada.

Co-ordination

13. Voluntary health organizations are playing a significant role in public health in Canada. The Association was in contact with 18 such organizations whose memberships total hundreds of thousands. All of these organizations are engaged in a field of specialized interest, but all are concerned with some phase of public health.

14. While paying full credit to the value of the work of these organizations, the necessity for co-operation and co-ordination of effort is becoming clearly evident. There is also need in Canada for more effective co-ordination of professional and voluntary health efforts. There should be a closer working relationship between these agencies and official health departments, and other professional health organizations.

15. Many of the associations contacted have expressed interest in collaborating with the Canadian Public Health Association. The Association, as the senior professional voluntary health organization devoted to public health in Canada, should be in a position to provide effective leadership in co-ordinating the activities of other voluntary health associations.

Canadian Journal of Public Health

16. The Journal is a valuable source of reference in the scientific literature and copies of the Journal are maintained in the leading scientific libraries throughout the world. Throughout the years the Journal has published original work in bacteriology, immunology, nutrition, vital statistics and other fields relating to preventive medicine and public health.

17. The Journal is the "voice" of the Association and a means of co-ordinating the activities and interests of the provincial branches with those of the national association by publishing news items, programs of meetings, and local reports. The Journal is also the official outlet for publishing policy statements issued by the Association. In addition to publishing original papers, the Journal must alert its readers to the key issues in public health today.

Consultant Advisory Service

18. The Consultant Advisory Service is intended to supplement those services provided by the federal and provincial departments of health or by national health agencies. This service is intended for the use of local and provincial departments of health and others working in public health and related areas. From time to time, there arise needs for advice and expressions of opinion based on expert knowledge that may best be provided by consultants through an unofficial body. The Canadian Public Health Association is a most suitable national organization to provide this service. Through the Consultant Advisory Service studies have been undertaken of the health departments of the cities of Hamilton, Halifax, and Dartmouth and the municipality of Halifax County.

Research

19. The Research Committee of the Association was established in 1962 and in the seven years of its existence has generally had two meetings annually. The terms of reference, reviewed several times by the Committee and considered generally still acceptable, are:

1. To advise on research policy.
2. To assess research proposals, projects and reports.
3. To co-ordinate research recommendations and activities.
4. To make recommendations regarding areas and subjects for investigation and research priorities.
5. To recommend appropriate and competent organizations and individuals to undertake specific research projects.
6. To stimulate training of:
   (a) Research personnel;
   (b) Health workers generally in research methods.
7. To serve as the advisory body to the Association for its Consultant Service.

20. As originally established, the Research Committee was composed of three members representing the Association, two from the Schools of Public Health, and two representing the Department of National Health and Welfare, with a Research Consultant. The activities and accomplishments of this Research Committee include the following:

(1) Some References on Canadian Health Services Evaluation Studies. A chronological list, 1949-1960, prepared for the Research Committee by the Epidemiology Division, Department of National Health and Welfare, and presented by Dr. Best (November 1962). (The Committee considers that this should be up-dated and made generally available).

(2) Research Methods in Public Health, An Annotated Bibliography with Special Reference to Canadian Problems and Experience, prepared by Dr. Gordon H. Josie at the request of the Research Committee, and published in the Canadian Journal of Public Health (January, 1963).

(3) The Halifax Study. The Committee received the report of the Study of Administration and Programmes of Health Departments of Halifax, Dartmouth, and Municipality of Halifax County, carried out under the C.P.H.A. Consultant and Advisory Services by a team under the direction of Dr. Vlado Getting (September, 1963).

(4) <u>A Study of the Activities of Nursing Personnel in Six Health Units and Municipal Health Departments in One Province of Canada</u>. A Report prepared by Miss Verna M. Huffman on a study initiated by the Committee and carried out under her direction with the active co-operation of the Research and Statistics Directorate, Department of National Health and Welfare (March, 1966).

(5) <u>A Statement of the Functions and Qualifications for the Practice of Public Health Nursing in Canada</u>, initiated by the Association and carried out by the Project Director, Miss Ruth Austin under the guidance of the Advisory Committee of Nurses appointed from across Canada. This report was presented to the Committee by the Chairman, Miss Verna Huffman and the Vice-Chairman, Miss Phyllis Jones and the Project Director. The report was subsequently published by the Association and distributed widely in both English and French (October, 1966).

(6) <u>A Study of the Activities of Local Health Service Personnel in Two Health Units in One Province of Canada</u>. A Report by Dr. E.W.R. Best on a Study initiated by the Research Committee and carried out under his direction with support from the Research and Statistics Directorate of the Department of National Health and Welfare (October, 1967).

(7) <u>A Policy Statement and a Brief on the Role of the C.P.H.A. in Research</u> were drafted for the Committee by two of its members, Dr. Harding le Riche and Dr. Jules Gilbert, respectively, and were considered at several meetings (September, 1967 and subsequently), but it was decided not to present these now on behalf of the Committee in view of the recommendations of the Commission on the Association. It was agreed, however, that these should be published in the Journal.

(8) <u>Environmental Health Study - Public Health Inspectors</u>. A Report on a Study initiated by the Research Committee at the request of the Board of Certification of Public Health Inspectors to the Association, and carried out by Dr. E.J. Young, Dr. W. Mosley, and Major A.S. O'Hara. The Report was prepared by the latter who had major responsibility for completion of the project. (Received December, 1968).

21. It should be recognized that the studies referred to above were virtually all supported by funds from government sources, especially from the Department of National Health and Welfare, mainly through the National Health Grants. In addition, the studies of nursing personnel and other health personnel in Ontario were conducted under the immediate direction of Consultants from that Department and the data processing and analysis were also done within the Department, particularly by its Research and Statistics Directorate. In the case of the Public Health Inspectors Study, the University of Toronto School of Hygiene provided data processing services. While it is to be hoped that the Association will continue to be able to call on Health Departments, particularly the National Department, and the Schools of Hygiene for assistance in terms of funds, consultants and other staff, and data processing services, plans for research activities must be made in relation to resources that the Association itself has or that it can specifically arrange for in advance of a project.

22. The Canadian Public Health Association is concerned with research because from it arise the essential stimulation and inspiration for further work and achievement. The role of the Association and the Committee with respect to research should also be considered in relation to any consultant advisory services that the Association may plan to offer. Generally, the Association itself should not be engaged directly in research but should have a stimulating, initiating, sponsoring, planning, and co-ordinating role. In addition, further attention should be given to the assessment and application of results of completed studies and to the need for evaluation and follow-up projects.

DISCUSSION AND RECOMMENDATIONS

23. We are aware that the Senate of Canada Special Committee on Science Policy is receiving extensive briefs from government departments and agencies as well as professional and academic bodies and that these will present much factual information and many recommendations and proposals for consideration of the Special Committee. We shall confine ourselves to matters of immediate concern to our Association on which we feel competent to offer advice, especially those that we feel obliged to bring to the Committee's attention in the public interest.

24. We have noted in its terms of reference that the Committee is to report on the science policy of the Federal Government including specifically its priorities and "the broad principles, the long-term financial requirements and the structural organization of a dynamic and efficient science policy for Canada". We shall concern ourselves particularly with these subjects and in doing so appreciate the fact that a comprehensive definition of scientific activities has been used to include research and development, data collection, scientific information, testing and standardization, and education. We find these terms and definitions appropriate for our discussion. We propose to refer first to certain broad principles and then to comment on present relevant government policy and organization, and finally, to discuss the priorities or emphases that we consider important in the development and application of a science policy for the Federal Government.

Broad Principles

25. We would recommend, first of all, that the science policy of the Government of Canada, insofar as health is concerned, recognize and be based on a comprehensive modern concept of health, health services, and their objectives. One of the best statements of the concept of public health is in the preamble to the Constitution of the World Health Organization, of which Canada is a founding member. In part the preamble states: "Health is a state of complete physical, mental, and social well-being and not merely the absence of disease or infirmity. The enjoyment of the highest attainable standard of health is one of the fundamental rights of every human being without distinction of race, religion, political belief, economic, or social conditions. Governments have a responsibility for the health of their peoples which can be fulfilled only by the provision of adequate health and social measures." The Government's terms of reference to the Royal Commission on Health Services referred to "such measures....as....will insure that the best possible health care is available to all Canadians".

26. The Association believes that to the traditional mainly preventive aspects of public health which involve communicable disease control, environmental sanitation, and health promotion through education and demonstration especially directed to mothers, infants, and children, there is now added a concern for the delivery of the total spectrum of personal care services to the individual in need of them. The latter concept in more fundamental terms was expressed by the Royal Commission in their statement of objectives in which they referred to "the enormous gap between our scientific knowledge and skills on the one hand, and our organizational and financial arrangements to apply them to the needs of men, on the other". The Commission went on to recommend "decisions to make all the fruits of the health sciences available to all our residents without hindrance of any kind". The Association suggests that the intrinsic value of these concepts in providing objectives and directions for decision-making should predominate over administrative considerations if the services are to be effective in achieving the desired goals.

Government Policy and Organization

27. Our concern for the effective application of existing knowledge leads us to recommend that the science policy of the Federal Government recognize its essential role in the health field, not only in terms of financial support, but especially in relation to the intra-mural research of the Department of National Health and Welfare which should mainly be of a developmental, operational and evaluative nature. This should lead to:

i) the identification of health problems and their priorities;

ii) the promulgation of standards and guides for the use of health agencies;

iii) the development of new and improved methods for surveillance and monitoring with respect to environmental hazards, communicable diseases, and drug misuse;

iv) the provision of specialized laboratory and other consultant services and facilities;

v) the evaluation and improvement of methods of implementation of protective legislation respecting foods, drugs, and substances injurious to health.

28. We suggest further that the present structure of federal government financial support for research is reasonably comprehensive and adequate. We refer especially to the provision of certain grants administered by the Department of National Health and Welfare: the Public Health Research Grant and the Health Resources Fund, as well as support provided through the Medical Research Council. This dichotomy of medical and other health research which appears artificial does, however, seem to us to serve a useful purpose. We particularly wish to recommend that there not be an undue emphasis in financial terms on clinical research to the possible neglect or disadvantage of perhaps less glamorous research of the developmental and evaluative kind.

29. We must add, however, that the increased needs for sufficient numbers of adequately trained public health personnel call for somewhat more financial support than is presently available, mainly through the Professional Training Grant. We suggest that this applies particularly to support of the Schools of Hygiene and departments of preventive medicine but extends also to faculties of dentistry, nursing, and others training individuals for public health services.

30. We suggest that the efforts of government agencies in these areas will be strengthened by ensuring the viability of appropriate professional and voluntary agencies to present a non-governmental point of view. We propose that this support be directed to maintaining an independent capability for service operations of a demonstration or experimental type and for research projects. We recommend that in this context federal funds be made available for such scientific activities judged to be in the interest of the public health.

Priorities

31. Priority areas for research and for demonstration projects have been discussed authoritatively on a number of occasions but we would like to make some suggestions in the light of the foregoing concepts and principles. We would emphasize first of all that demonstration projects should have evaluative research included if they are to serve their intended purpose. We suggest that demonstration projects and operational studies are needed in respect to the following:

i) alternative patterns of health services organization, including especially regionalization not only as an advisory and co-ordinating device but as an authoritative and operational structure;

ii) alternative patterns of health practice including especially the use of group practice on a clinic basis in association with official health centres. It has been suggested, for instance, that there should be provision for the doctor to have organizational and service support outside of the hospital analogous to services available to him within these institutions;

iii) the use of auxiliaries and aides of various types to support highly qualified persons in general or specialist services, with a view to optimum use of available health manpower;

iv) analyses of the cost-benefit type to explore the effective use of resources in meeting stated objectives; this will require the development of more adequate statistics of public health services in terms of objectives, resource use, and costs.

32. In the more traditional public health areas the Association believes that the needs for epidemiological and other research in such priority areas as infant mortality, cancer, accidents, and mental illness are virtually self-evident but need to be reiterated and included in the planning of scientific activities and the financial and other provision for research. We would also mention that the communicable diseases require attention from the standpoint of possible eradication of some long-time problems such as tuberculosis, and the more effective treatment of the veneral disease problem, and further that more attention should be directed to intensified immunization programs in Canada.

33. Finally, the problems of environmental pollution, which are of long standing, are increasing in magnitude and complexity and will require all our scientific skills if our health standards are to be maintained, let alone improved, in Canada. In this connection, we view with concern the tendency to some ambiguity in direction of activities with respect to the environment as between health departments and other agencies. Therefore, with respect to environmental pollution the Association considers that regardless of the possible advantages of having certain environmental measurements made by other agencies, it is imperative that the assessment of health effects be the responsibility of health agencies alone. This may involve other agencies making measurements and providing data to meet the requirements of the health agencies and the development by the latter of new procedures of measurement, analysis, and interpretation.

Submitted on behalf of the Association by:

Gordon H. Josie, Sc.D., M.P.H., M.Sc.,
Chairman, Research Committee,
Canadian Public Health Association.

APPENDIX 194

S U B M I S S I O N

to the

SPECIAL COMMITTEE ON SCIENCE POLICY

by

Canadian Nurses' Association
50 The Driveway
Ottawa 4, Canada

27 February 1969

To Special Committee on Science Policy

In response to the invitation contained in a communication from the Honorable Maurice Lamontagne, dated 10 January 1969, the Canadian Nurses' Association is pleased to submit the following brief for the Committee's consideration.

We understand that in this third phase of the Committee's work "many submissions will be received which are read into the record, but where no public discussion is required." Although representatives of the Canadian Nurses' Association do not wish to appear before the Committee, we request that this submission be "read into the record."

When your hearings are concluded, and when science policy affecting nursing and other health professions is being formulated, we would be pleased and readily available to interpret the role of nurses and nursing in the scientific world.

As outlined in your "Guide for Submission of Brief" under 1.2., the curriculum vitae of the Association's Executive Director is attached as Appendix A.

27 February 1969

Canadian Nurses' Association

1. The Canadian Nurses' Association.

1.1 The Canadian Nurses' Association (henceforth referred to as CNA) was formed in 1908 and incorporated by a special Act of Parliament in 1947.

1.2 CNA is a federation of the ten provincial nurses' associations and is a member of the International Council of Nurses. (CNA is the second largest association in the international association). As such, it is the recognized voice of Canadian nursing at the national and international level.

1.3 CNA has a membership of approximately 80,000 registered nurses -- the largest association of health professionals in Canada. The registered nurse membership includes those nurses who have graduated from university schools of nursing -- holding baccalaureate, master's or doctoral degrees -- and those graduated from diploma schools of nursing.

1.4 The promotion of optimum health is the basis of the profession's concept of nursing care. A nurse's ultimate goal is the maintenance of good health of the individual. CNA's program and policies provide the means to promote the highest standards of nursing practice to the end that the best possible level of health service may be available to all Canadians.

CNA recognizes the need for all disciplines, organizations, agencies or officials responsible for health services to Canadians to work in concert toward their common objectives. Its policies facilitate and invite this community of effort.

1.5 CNA headquarters is located in Ottawa and houses a staff of approximately forty. This permanent staff provides services to outside agencies as well as to members. Among these services are:

1.5.1 Research and Advisory Services.

The basic function of the Research and Advisory Department is to study conditions and events effecting nursing, identify problems, recommend corrective action, and provide consultation services. In pursuing this work, liaison with appropriate federal and provincial authorities and organizations is maintained.

An important by-product of the research activity is the publication of all statistical data gathered in its process. This includes: an annual inventory of all registered nurses in Canada by province, classified by employment status, marital status, age and sex; Nursing Department staff turnover rates; salaries and qualifications of faculty in nursing schools; student enrollment and graduation by type of program, and others. The yearly publication "Countdown - Canadian Nursing Statistics", is available, on request, from CNA House, 50 The Driveway, Ottawa.

1.5.2 National Nursing Library and Archives.

CNA House contains a modern library of over 5,000 titles and is the most comprehensive collection of nursing literature in the nation. Its repository collection of nursing studies is a major resource for research in nursing in Canada, and the periodical collection of some 300 titles is probably one of the best in the world.

The loan service and reference service is used extensively by nurses and others across Canada and throughout the world. These services are available to all agencies or individuals interested in nursing.

The Archives houses the only national collection of Canadiana in nursing.

1.5.3 Publication of Nursing Journals in English and French.

CNA publishes the only English and French national professional nursing journals in Canada. The journals, "The Canadian Nurse" and "L'infirmière canadienne" are both published monthly and contain current news, technical articles, comment and opinion, and product and book reviews.

1.5.4 Communications.

The Information Services department publishes reports of all formal studies and programs undertaken by the Association in both French and English. It also provides information for distribution to the public through press, television, and other media in the form of press releases and other informational material.

The Association considers participation with government agencies and allied professional groups, at both the provincial and national level, to be a significant part of its overall responsibility.

In this capacity it sits on planning councils, provides consultant services, participates in conferences, co-sponsors activities, and collaborates with medical associations, hospital associations, government agencies, and others in the planning and control of health services for Canadians. The Association welcomes opportunities to share its resources to this end.

2. Scientific and Research Activities.

Nursing is both an art and a science. Over the past decade science and technology have advanced rapidly in the entire health field. The standards of nursing care available now and in the future will depend on the ability of the profession to produce members educated and capable of adjusting to and advancing with the developments in science and technology.

The application of established scientific and technological principles and procedures to optimize efficiency through appropriate division of labour, mechanization of material handling, automation of data processing and so forth, although generally achieved in industry, has been largely overlooked in the health field.

Effective utilization of health personnel (predominantly nurses) can best be realized through the application of such principles. Too, the need is evident to prepare nurses through considerably stronger and richer educational programs than are now offered in Canadian schools of nursing so that graduate practitioners will be competent to perform effectively in the more sophisticated environment now developing in the health field.

> To this end, the Canadian Nurses' Association would support a Science Policy for Canada that would
>
> (a) enrich the educational content in the social, biological and technological science in educational institutions preparing beginning nurse practitioners, and
>
> (b) provide additional depth in the scientific field for education of graduate nurses obtaining master's and doctoral degrees to prepare them for the role of
>
> -- nurse researcher
>
> -- clinical nurse specialist, and
>
> -- nurse scientist.

2.1 Social Research by the Canadian Nurses' Association.

Examples of social research carried out by CNA in the last ten years are:

2.1.1 From 1958-1960 CNA conducted a Pilot Project for the Evalution of Schools of Nursing in Canada. This was a national survey of schools of nursing and included an intensive survey of 25, of the 170 schools of nursing, selected according to geographical location, size, control and type of program. Data were collected by means of questionnaires, information schedule, interview and

observation, The Report contained four recommendations:

1. That a re-examination and study of the whole field of nursing education be undertaken.

2. That a school improvement program be initiated to assist schools in upgrading their educational programs.

3. That a program be established for evaluating the quality of nursing service in the areas where students in schools of nursing receive their clinical experience.

4. That a program of accreditation for schools of nursing be developed by the Canadian Nurses' Association.

2.1.2 Nursing Education in Canada -- published by Royal Commission on Health Services. Principal Investigator, Helen K. Mussallem, R.N., Ed.D., Director of Special Studies, Canadian Nurses' Association, 1964.

Purpose

1. To examine the present types of programs for the preparation of nurses and other workers within the occupation of nursing.

2. To assess these programs in relation to the nursing needs of the country.

3. To make proposals for necessary and desirable changes in the education of nursing personnel.

Method

Examination, description and analysis of all types of formal educational programs for personnel providing nursing care. Data were collected by means of interview, questionnaire and survey.

Conclusions and Proposals

1. The deplorable situation of unqualified teachers must be remedied as soon as possible.

2. Immediate plans should be directed towards introducing diploma schools of nursing into the post-high school system of the country.

3. A complete revision of the types of educational programs in nursing is essential.

4. Sufficient potential candidates for leadership positions in nursing should be channelled into university schools of nursing.

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1 Mussallem, Helen K.

Spotlight on nursing education; a report of the pilot project for the evaluation of schools of nursing in Canada. Ottawa, Canadian Nurses' Association, 1960.

5. The present number of university schools are too few to meet the projected total enrollment of 60,000 students by 1991.

6. Programs should be established to attract older women into nursing.

7. To add vitality to the educational programs, programs for research in nursing practice should be carried on.

8. More graduate programs in nursing should be introduced for preparation of nurses in research, consultation, administration, and as nursing specialists.

9. Experimentation in educational programs preparing nurses should be encouraged.

2.1.3 A Course For the Future -- study conducted and published by CNA in 1966.

Focus

Non-university programs, excluding schools of nursing sponsored by religious bodies.

Method

(a) Discussion and reading of submissions and published accounts; general absence of field work (with minor exception).

(b) Diary accounts (and some participant observations) of university class and two classes of hospital students.

General Summary Recommendation

The Canadian Nurses' Association, in consultation with provincial bodies, should immediately establish working parties to prepare for specific experiments -- ideally in different parts of the country -- along the lines suggested in this report. Such experiments should be appraised.

2.1.4 School Improvement Program -- study conducted by Glenna S. Rowsell, R.N., Dip.N.E., Director of the Project.

Purpose

1. To identify the principles of a sound program of education.

2. To initiate changes or improvements in harmony with such principles

3. To apply these principles in preparing the type of practitioner of nursing that has been established in the objectives of the school.

Method

Assisting faculty in diploma schools of nursing to analyze and to evaluate their progress in terms of a national set of criteria. A self-administered questionnaire was designed for data collection, a self-evaluation guide was developed for assessing progress and two series of workshops were held for interpretative and educational purposes.

Conclusions

There were fifteen conclusions drawn from this study; one significant conclusion was:

> There is a need for better understanding of how to develop and utilize the philosophy and objectives as a basis for the development of the total program, the selection of learning experiences, and the evaluation of the program. There is a need to indicate clearly the level of performance for which the graduate is prepared, and to identify what nursing is, what education is, and how students learn.

2.1.5 Evaluation of the Quality of Nursing Service -- Principal Investigator, Lillian F. Campion, R.N., M.A., Canadian Nurses' Association, Director of the Project.

Objectives

1. To establish national criteria for the evaluation of the quality of nursing service.
2. To establish methods, procedures, and tools to be used for the evaluation.
3. To determine if the quality of nursing service in a selected number of hospitals meets the established criteria.
4. To identify factors which appear to influence the quality of nursing service.
5. To identify areas for study and/or experimentation.
6. To make recommendations to the Canadian Nurses' Association for action as indicated by the findings.

Method

Survey of twelve public general hospitals selected according to province, size of community, type of control, bed capacity, and schools of nursing. Data were collected by means of a check list, questionnaire, interview and observation.

Recommendations

The Report contained five recommendations; the first two were:

1. That the Canadian Nurses' Association initiate a program to assist those responsible for the administration of nursing service within hospitals to study and evaluate their own department and to initiate improvements as indicated.

2. That the Canadian Nurses' Association, Canadian Medical Association and Canadian Hospital Association study ways and means of clarifying the understanding and expectation of doctors, nurses and hospital administrators in relation to their respective roles, functions and relationships within the field of hospital patient care.

2.1.6 The above are examples of more recent studies. However, as early as 1927, CNA was involved in social research.

In 1927 the Canadian Nurses' Association and the Canadian Medical Association, by joint committee, began work on a study of nursing education in Canada. In 1929, Dr. G.M. Weir, Professor of Education and Head of the Department of Education at the University of British Columbia, was appointed Director of the Survey.[1] The problems studied were of economic, educational and sociological character. The Report presented a comprehensive factual statement of nursing conditions in Canada, with a statement of recommendations at the close of each chapter. Many of the weaknesses identified by Dr. Weir are still evident in schools of nursing in Canada in 1969.

2.1.7 There was also another early significant study. In the autumn of 1946, the Canadian Nurses' Association, with financial assistance from the Canadian Red Cross Society, began an experiment in nursing education; the Metropolitan Demonstration School of Nursing in Windsor, Ontario.

The purpose of this experiment was:

> "To conduct a school of nursing as an educational institution for the purpose of training good bedside nurses prepared also to be eligible for further training in any of the special fields of nursing."

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1 Weir, G.M.
Survey of nursing education in Canada. Toronto, University of Toronto Press, 1932.

An evaluation of the school by Dr. A.R. Lord of Vancouver was completed in 1952, with financial assistance from the Ontario Department of Health through a federal-provincial grant.[1]

2.1.8 An example of a unique study in nursing carried out in an early period (1954) is the "Head Nurse Study". A study of the functions and activities of head nurses in a General Hospital was carried out in the Ottawa Civic Hospital by the Research Division of the Department of National Health and Welfare at the request of the Canadian Nurses' Association.[2] The study, by detailed investigation of the activities of the head nurse, was an endeavour to find ways of conserving the time of the head nurse in the best interest of patient care.

2.2 Research Completed by Canadian Nurses (including some by sociologist) on Canadian Nursing. See Appendix B, "Canadian Nursing Studies".

As a resource for research and studies on nursing in Canada, CNA has two continuing projects. It maintains

(a) an Index of Canadian Nursing Studies, and

(b) a Repository Collection of Nursing Studies.

The Index of Canadian Nursing Studies (see Appendix B), published December 1967, reveals that to that date 262 studies were completed by Canadian nurses or were concerned with Canadian nursing. The largest number have been completed by nurses, many of whom were studying at the master's or doctoral level. Approximately 100 of

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[1] Lord, Dr. A.R.
Report of the evaluation of the Metropolitan School of Nursing, Windsor, Ontario. Ottawa, Canadian Nurses' Association, 1952.

[2] A study of the functions and activities of head nurses in general hospitals. Ottawa, Research Division, Dept. of National Health & Welfare, 1954.

these studies were completed by the Canadian Nurses' Foundation scholars.

2.3 The Canadian Nurses' Foundation and Research.

The Canadian Nurses' Foundation is a national incorporated body (incorporated in 1962 under the Canadian Companies Act by Letters Patent) organized to acquire funds to provide fellowships and provide for research in nursing science.

This Foundation has as its objects (in the Letters Patent),

(a) to provide bursaries, scholarships and fellowships for nurses in the field of graduate studies at the Master's and Doctorate levels;

(b) ... to undertake research in nursing science which may help to advance the knowledge and art of members of the nursing profession with a view to providing the best possible health care and attention.

Since its inception in 1962, the Canadian Nurses' Foundation has provided financial assistance to 98 nurse scholars studying at the master's and doctoral level.

Funds to support the Canadian Nurses' Foundation are provided by Canadian nurses. The awards made to nurse scholars are generally insufficient to fund the period of time for preparation of a research study or dissertation -- a partial requirement for fulfillment of the doctoral degree.

Because the research studies by CNF doctoral students are necessary to add to the body of knowledge in nursing in Canada, and because there is a dire need to have nurses prepared at the doctoral level to conduct research, the following recommendation is offered:

THAT the Special Committee on Science Policy support the proposal 134 of the Royal Commission on Health Services,

> "That as part of a seven year crash programme, Professional Training Grant bursaries of $3,500 be made available so that more graduate nurses having the baccalaureate degree be enabled to obtain the master's degree in nursing to qualify them for appointments as university instructors",[1]

and

THAT in any proposals for research funds made by the Special Committee on Science Policy, funds be included for nurses to obtain doctoral degrees to qualify them for research, for appointments as university faculty, as a nurse scientist, and a clinical specialist.

2.4 Current Research Carried on by CNA.

CNA believes that one of the profession's responsibilities is to add to the body of its knowledge. It also believes that nurses, either as principal investigators or as a team member, should conduct more research in the care of the sick, in the maintenance of positive health, in nursing education and administration of nursing services.

The nursing profession's concern in research has as its ultimate objective the patient's well-being. This does not mean that nurses are abdicating the administration of direct patient care. On the contrary, nurses are making every effort to retain highly skilled practitioners "at the bedside" and to improve and enhance nursing practice through social research conducted by qualified nurse investigators.

Through the Research and Advisory Department (see 1.5.1 above), CNA

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[1] Royal Commission on Health Services, Vol. 1. Ottawa, Queen's Printer, 1964. p.68

studies conditions and events effecting nursing and health services, identifies problem areas, and recommends corrective action. Information on these activities is available from the CNA.

In addition, CNA collects data annually on:

(a) Professional Nursing Personnel -
The over 120,000 registered nurses in Canada submit information on marital status, age, sex, employment status, educational preparation, field of employment and present position. This information is developed into tables classified as to, inventory, distribution in institutions, turnover in institutions, nurse faculty members, nurses with academic degrees, and licensure.

(b) Professional Nursing Education -
Annual data is collected on initial programs (numbers and types provincially and nationally, enrollment, admissions, graduations) and post-basic programs.

(c) Economic Status of the Nursing Profession -
Data collected annually include federal government salary schedules, nurse faculty salaries, and salaries in public general hospitals.

(d) Auxiliary Nursing Personnel -
Although the Canadian Nurses' Association represents only professional nurses, it collects information and provides data on auxiliary nursing personnel, their distribution in institutions, turnover, educational programs and licensure.

(e) Other related data is also collected, e.g., hospital facilities, services and finance.

The CNA publication "Countdown 1968 - Canadian Nursing Statistics" contains over 130 statistical tables on the above data.

3. Research Proposals and Funding

3.1 Proposals for scientific study of critical problems have been made by CNA to the Federal government over the years without tangible results.

Some approaches were made in cooperation with the Canadian Medical Association and the Canadian Hospital Association, e.g., "A Project to Study the Transfer of Functions among the Health Professions." CNA favors a multidisciplinary approach to research that covers a wide spectrum of health workers or problems. To this end, CNA would support Recommendation No. 200 of the Report of the Royal Commission on Health Services (Vol. 1, page 92):

> "That the necessary legislation be enacted as soon as possible expanding the Medical Research Council into the recommended Health Science Research Council and providing it with adequate funds."

Further, CNA would support Recommendations 181, 182 and 183 of the Royal Commission on Health Services (Vol. 1, page 81):

> "That the Council conduct and provide grants for research in the medical, biological, and related sciences, basic drug research, and any other scientific research including research in the social sciences, having as its objective the improvement of the health of the Canadian people."
>
> "That the Council support research concerning the most effective training and use of health workers."
>
> "That it be a continuing responsibility of the Council to conduct or provide grants for the conduct of studies evaluating the effectiveness, efficiency, and co-ordination of the various elements of the health services complex."

3.2 CNA would re-affirm its recommendation to the Science Secretariat of the Privy Council, submitted 22 February 1968:

> "Because national growth and prosperity are dependent upon health and education, and because professional nurses comprise the largest sector of the health occupations force, and because nurse-faculty have a responsibility to contribute to the overall purposes of higher education through

scholarly research, and because numerous topics of research need to be undertaken to provide quality patient care and quality education for students, it is recommended:

> THAT provision for Nursing Research Grants, of no less than $100,000, for the first year, be made available through the Science Secretariat of the Privy Council, so that nurse-faculty and graduate nurse students in Canadian university schools of nursing may begin needed research studies.

and

> THAT provision for these Nursing Research Grants be substantially increased, each year, as additional Canadian nurse-faculty become qualified to undertake major research projects.

and

> THAT money appropriated for nursing research be channeled through the Canadian Nurses' Foundation."

By virtue of the Letters Patent and By-laws, the Canadian Nurses' Foundation, a non-profit corporation, has through its purposes and objectives established channels for the distribution of funds for nursing research on a nation-wide basis.

3.3 Based on information gathered through CNA's statistical program, the need for further research is identified in the following areas of adult human resource development:

Proposal I: Registered Nurses Not Employed in Nursing

Fact

In 1968, there were 24,108 nurses who were registered but not employed in nursing.

Questions

1. How many of these nurses are employed in an occupation other than nursing?

   What are the reasons for their not working as a nurse?

2. What are the reasons that prevent those who are not currently employed from working as a nurse?

3. What proportion of those not currently employed expect to return to work as a nurse for pay in the future?

   When do they plan to return to nursing?

How many expect to be full-time workers on re-entry?

4. What personal characteristics describe those not currently employed who expect to:

   a. return to nursing?

   b. not return to nursing?

Proposal II: Registered Nurses Employed Part-time in Nursing

Fact

In 1968, there were 27,593 registered nurses who were working part-time in nursing.

Questions

1. Who are their employers?

2. What is their full-time equivalent to the nursing work force?

3. Why are they working part-time rather than full-time?

4. What was their past pattern of work?

5. What is their expectation of work in the future?

6. What personal characteristics describe the present part-time worker who expects to:

   a. continue to work part-time?

   b. convert to full-time work?

   c. drop out of the work force?

Proposal III: Educational Goals of Registered Nurses

Fact

In 1968, there were 18,548 registered nurses who held a university degree or had some credits toward a Baccalaureate Degree.

Questions

1. What proportion of nurses who have some educational preparation in a university desire additional academic preparation?

   a. What level of university preparation do they desire within the next five years?

   b. In what fields of nursing are they employed?

   c. What positions do they hold?

   d. How many of them plan to enroll in a university next year as a full-time or part-time student?

e. How many of them have earned sufficient credit to complete requirements for a degree in twelve months or less if they were full-time students?

f. What type of financial assistance would be required to enable them to attend a university as a full-time student for one year?

2. What proportion of nurses who are motivated toward academic preparation are delayed in achieving their educational goals?

   a. What are the reasons for delay?

   b. What remedial action is indicated?

Proposal IV: Foreign Nurses Registered in Canada

Fact

In 1967, 3,328 nurses who were educated in foreign countries were licensed, for the first time, as registered nurses in Canada.

Questions

1. Where did they obtain their basic preparation as a nurse?

2. What was their work history prior to immigration?

3. Why did they come to Canada?

4. What are their personal characteristics (age, marital status, etc.)?

5. What was their work history following immigration?

6. How many expect to remain in Canada?

   a. What are their reasons for staying?

7. How many expect to leave Canada?

   a. What are their reasons for leaving?

   b. Where do they expect to go?

Proposal V: Nurses from Canada Registered in U.S.A.

Fact

In 1967, there were 1,351 nurses from Canada licensed as registered nurses in the U.S.A.

Questions

1. How many of the nurses are Canadian Citizens?

   a. What proportion of these obtain citizenship through naturalization?

2. Where did they obtain their basic preparation as a nurse?

3. What was their work history in Canada?

4. Why did they leave Canada?

5. What are their personal characteristics (age, marital status, etc.)?

6. What was their work history following immigration to the U.S.A.?

7. How many expect to return to Canada?

   a. How soon do they expect to return?

   b. What are their reasons for returning?

8. How many expect to immigrate to another country?

   a. Where do they expect to go?

   b. What are their reasons for leaving?

9. How many expect to remain in the U.S.A.?

   a. What are their reasons for staying?

CONCLUSION

The Canadian Nurses' Association, on behalf of 80,000 registered nurse members, reaffirms its conviction that research in nursing practice is vital to the provision of adequate health care for Canadians.

In Canada, there has been an uneven pace in the progress of research in medicine and nursing. If funds continue to be made available for research in medicine and not for research in nursing, the results of medical research will not be reflected in the health status of the population.

Research and funding of research is urgently required in the following areas:

- Roles and interrelationships of health workers, for example,

  The nurse's role as a therapist in psychiatry,

  The nurse's role in follow-up of psychiatric in-patients,

The role of the nurse in the use of isotopes as therapeutic agents in cancer,

The role of the nurse in developing clinical techniques,

The unique role of the nurse in community practice,

The role of the clinical specialist,

The nurse's role in identifying or diagnosing the patient's total needs -- hospital and community, and

The role of the nurse as a member of the health team.

- Educational preparation of health workers, for example, model building, theory testing, curriculum design, use of clinical laboratory, verbal and non-verbal communication.

- Recruitment and maintenance of adequate work force. (See proposals 1 - 5 under 3.3).

- Provision of educational facilities and faculty. (See:

1. CNA Submission to the Study of Support of Research in Universities for the Science Secretariat of the Privy Council, February 1968;

2. Canadian Graduate Nurse Students Studying for Master's and Doctoral Degrees in National League for Nursing Accredited Programs in Colleges and Universities in the United States of America. Canadian Nurses' Association, June 1968.

3. CNA Submission to the Commission on Relations Between Universities and Governments. 1969.)

(Available from CNA).

Support of nursing research and the preparation of nurse researchers would promote "the achievement of the highest possible health standards for all our people".

First Session—Twenty-eighth Parliament
1968-69

THE SENATE OF CANADA

PROCEEDINGS

OF THE

SPECIAL COMMITTEE

ON

SCIENCE POLICY

The Honourable MAURICE LAMONTAGNE, P.C., *Chairman*
The Honourable DONALD CAMERON, *Vice-Chairman*

No. 79

BRIEFS NOT SUPPORTED BY ORAL EVIDENCE:

195. Brief submitted by the Canadian Heart Foundation
196. Brief submitted by the Canadian Association of Chiefs of Police, Inc.
197. Brief submitted by the Brewers Association of Canada
198. Brief submitted by the Voice of Women
199. Brief submitted by the Canadian Easter Island Expedition Society
200. Brief submitted by the Canadian Council of Furniture Manufacturers
201. Brief submitted by the Consumers' Association of Canada
202. Brief submitted by the Canadian Institute of Mining and Metallurgy
203. Brief submitted by the Canadian Home Economics Association
204. Brief submitted by the Canadian Manufacturers' Association

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MEMBERS OF THE SPECIAL COMMITTEE

ON

SCIENCE POLICY

The Honourable Maurice Lamontagne, *Chairman*

The Honourable Donald Cameron, *Vice-Chairman*

The Honourable Senators:

Aird
Belisle
Blois
Bourget
Cameron
Carter
Desruisseaux
Giguère
Grosart
Haig
Hays
Kinnear
Lamontagne
Lang
Leonard
McGrand
Nichol
O'Leary (*Carleton*)
Phillips (*Prince*)
Robichaud
Sullivan
Thompson
Yuzyk

Patrick J. Savoie,
Clerk of the Committee.

ORDERS OF REFERENCE

Extract from the Minutes of the Proceedings of the Senate, Tuesday, September 17th, 1968:

"The Honourable Senator Lamontagne, P.C., moved, seconded by the Honourable Senator Benidickson, P.C.:

That a Special Committee of the Senate be appointed to consider and report on the science policy of the Federal Government with the object of appraising its priorities, its budget and its efficiency in the light of the experience of other industrialized countries and of the requirements of the new scientific age and, without restricting the generality of the foregoing, to inquire into and report upon the following:

(*a*) recent trends in research and development expenditures in Canada as compared with those in other industrialized countries;

(*b*) research and development activities carried out by the Federal Government in the fields of physical, life and human sciences;

(*c*) federal assistance to research and development activities carried out by individuals, universities, industry and other groups in the three scientific fields mentioned above; and

(*d*) the broad principles, the long-term financial requirements and the structural organization of a dynamic and efficient science policy for Canada.

That the Committee have power to engage the services of such counsel, staff and technical advisers as may be necessary for the purpose of the inquiry;

That the Committee have power to send for persons, papers and records, to examine witnesses, to report from time to time, to print such papers and evidence from day to day as may be ordered by the Committee, to sit during sittings and adjournments of the Senate, and to adjourn from place to place;

That the papers and evidence received and taken on the subject in the preceding session be referred to the Committee; and

That the Committee be composed of the Honourable Senators Aird, Argue, Bélisle, Bourget, Cameron, Desruisseaux, Grosart, Hays, Kinnear, Lamontagne, Lang, Leonard, MacKenzie, O'Leary (*Carleton*), Phillips (*Prince*), Sullivan, Thompson and Yuzyk.

After debate, and—
The question being put on the motion, it was—
Resolved in the affirmative."

Extract from the Minutes of the Proceedings of the Senate, Thursday, September 19th, 1968:

"With leave of the Senate,
The Honourable Senator Lamontagne, P.C., moved, seconded by the Honourable Senator Benidickson, P.C.:

That the name of the Honourable Senator Robichaud be substituted for that of the Honourable Senator Argue on the list of Senators serving on the Special Committee on Science Policy.

The question being put on the motion, it was—
Resolved in the affirmative."

Extract from the Minutes of the Proceedings of the Senate, Wednesday, February 5th, 1969:

"With leave of the Senate,

The Honourable Senator McDonald moved, seconded by the Honourable Senator Macdonald (*Cape Breton*):

That the names of the Honourable Senators Blois, Carter, Giguère Haig, McGrand and Nichol be added to the list of Senators serving on the Special Committee on Science Policy.

The question being put on the motion, it was—
Resolved in the affirmative."

ROBERT FORTIER,
Clerk of the Senate.

BRIEFS NOT SUPPORTED BY ORAL EVIDENCE

The Committee has received many briefs which were not supported by oral evidence given before it. It has been decided to print these briefs separately from the ordinary proceedings, in several volumes, of which this is the second. The list of briefs printed in this volume is as follows:

195.—Brief submitted by the Canadian Heart Foundation

196.—Brief submitted by the Canadian Association of Chiefs of Police, Inc.

197.—Brief submitted by the Brewers Association of Canada

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203.—Brief submitted by the Canadian Home Economics Association

204.—Brief submitted by the Canadian Manufacturers' Association

ATTEST

Patrick J. Savoie,
Clerk of the Committee.

APPENDIX 195

B R I E F

to the

SENATE OF CANADA

SPECIAL COMMITTEE ON SCIENCE POLICY

OTTAWA

CANADIAN HEART FOUNDATION

MAY, 1969

CANADIAN HEART FOUNDATION

BRIEF ON SCIENCE POLICY

CONTENTS

CANADIAN HEART FOUNDATION

BRIEF ON SCIENCE POLICY

SUMMARY

S1. The Canadian Heart Foundation is the voluntary health agency for heart disease in Canada. It is a federation of the Provincial Heart Foundations all of which are devoted to the prevention of cardiovascular disability and death. Their programmes are concerned primarily with the support of cardiovascular research in Canadian universities and associated hospitals. They have modest educational programmes for the health professions and for the general public. They raise money to support these programmes by public subscription.

S2. The biomedical sciences, or basic biology and the health sciences, have yielded rich dividends for the relatively small funds invested. They have been responsible for great advances which have been made in health care in the past twenty years. The major portion of the funds are spent in the universities or other academic institutions where they have been a significant stimulus to all levels of training in the health professions.

S3. University budgets have not allowed sufficiently for support of scientific activity, so essential to their survival. Government and other agency support of these activities has permitted the universities to carry forward their scientific creativity.

S4. Scientific activities in industry have also received substantial support and encouragement from the Canadian Government. The majority of the general expenditures on research and development in Canada has been within federal Departments and their Agencies. The Canadian people has reason to be proud of the advances made in Canadian laboratories.

S5. The funding of research, development and innovative activity in Canada is relatively modest in comparison with that in other developed countries. This is true for health-related goals, as well as for other aspects of Canadian life.

S6. With a great diversity of scientific activities, support programmes and their administration, there has been lack of communication and co-ordination. With no clear locus of Government concern, it has been difficult to assess either aims, or the total impact of federal support programmes on the needs of the nation. The best possible selection for federal expenditure in the national interest will require new relationships, with greater participation and consultation, between Government and informed citizens. Planning and programming for the longer term demands the development of a Science Policy for Canada.

S7. The Canadian Heart Foundation is grateful for this opportunity to express its views and hopes that the Committee will agree to a formal structure for the continuation of public dialogue through an arm of the Parliament of Canada.

CANADIAN HEART FOUNDATION

BRIEF ON SCIENCE POLICY

RECOMMENDATIONS

R1. Canadians must establish clearly defined national and international objectives in scientific affairs. (Section E, Para. 45).

R2. The Government of Canada should create a mechanism for the co-ordination of science policy and for the participation of informed and concerned citizens in the development and continuation of science objectives. The Special Committee of the Senate on Science Policy has initiated this process. It should continue as a Standing Committee of the Senate, and maintain a public forum for discussion. Moreover, it is suggested that the Science Council should invite submissions from citizens and groups before recommending objectives in scientific affairs for Canada. (Section E, Para. 46).

R3. There should be a systematic and open review of these objectives, and of the publicly declared projections by which they will be reached. (Section E, Para. 47).

R4. A set of priorities for Government of Canada expenditure on scientific research, development and innovation should be established and systematically reviewed. The priorities may change, but they must be consistent with the published objectives in scientific affairs, and with their anticipated projections over several years. (Section E, Para 48).

R5. The Chairman of the Privy Council Committee on Scientific and Industrial Research should be other than the President of the Treasury Board. The Chairman of a Senate Standing Committee on Scientific Affairs would be a most satisfactory Chairman of this important Committee. (Section E, Para. 54).

R6. All Government Agencies and Departments making funds available for the support of scientific activities in Canada should take regional disparities into account. There is a need for what might be considered "seed funds". (Section E, Para. 57).

R7. Each Department and Agency of Government should have the obligation to undertake a programme of operational research to review its own programmes and the ability to innovate at the appropriate time. (Section E, Para. 51).

R8. Those Departments or Agencies that have extensive Intra-Mural Research and Development Programmes should have advisory panels of non-government as well as government persons, on whom they can call. (Section E, Para. 52).

R9. The Intra-Mural Expenditures on Scientific Activities of Government Departments and Agencies should be subject to a similar periodic external peer assessment and review, as the Academic and Industrial Support Programmes. (Section E, Para. 59).

R10. The Extra-Mural Support Programme of the National Research Council should be separated from the Intra-Mural Programme by dividing these two functions between two separate agencies though both reporting to Cabinet through the Chairman of the Privy Council Committee. Should the Extra- and Intra-Mural Programmes for the support of scientific activities of any other Department or Agency reach a similar magnitude, the same recommendation would apply. (Section E, Para. 61).

R11. The Government of Canada should create new arrangements for the stimulation of industrial research, development and innovation in Canada. These arrangements may take many forms. Government contracts and grant proposals to industry should be subject to a similar type of external critical appraisal as the Support Programmes for Academic Research, and reviewed periodically by the institution of a systematic technical assessment. (Section D, Para. 39).

R12. The Government of Canada should devise broader consultative procedures with greater involvement of the academic community in the allocation of funds to the various sectors of scientific research and development associated with Canadian universities. (Section C, Para. 29).

R13. The systematic review of all such allocations of funds towards scientific activities in the universities, whether capital or operating, should relate to national goals, and be on the basis of national competition, and of examination by scientific peers. (Section C, Para 30).

R14. The role and independence of the academic community in education and research must not be compromised by excessive demands for additional service functions in the community, particularly if these can be satisfied by other mechanisms, or by the awarding of grants or contracts to the universities that deal with classified material, except in times of national emergency. (Section C, Para. 31).

R15. Appropriate supply and distribution of properly qualified manpower in Canadian scientific activities can be assisted by the development by the Canadian Government of an information bank of scientific manpower. In addition, the mobility of personnel between producer and consumer, between Canadian academic institutions and Canadian governments and industry, and with co-operative programmes abroad, should be facilitated. (Section D, Para. 40).

R16. Biomedical research and development support is critical to the attainment of the personal health, prosperity and the leisure goals of Canadians. It must be given a higher priority to permit it to increase rapidly to a level of government expenditure appropriate to the goals of a leading industrial country. (Section B, Para. 21).

R17. The actual disposition of funds for the support of scientific research and development in the biomedical sciences should be primarily in Canadian universities and their associated colleges and hospitals. (Section B, Para. 22).

R18. The Canadian Heart Foundations believe that all levels of government should take cognizance of cardiovascular disease, Canada's number one health problem, and that each government should take actions that are consistent with its solution. (Section A, Para. 9).

SCIENCE POLICY FOR CANADA

A submission prepared for the

SPECIAL COMMITTEE ON SCIENCE POLICY

SENATE OF CANADA

Ottawa

CANADIAN HEART FOUNDATION

May, 1969.

A The Canadian Heart Foundations

1. The heart and blood vessel diseases are Canada's greatest public health problem. They account for more than half of the deaths in this country each year. The Canadian Sickness Survey (1950-51) showed heart disease to be the most frequent cause of disability. A more recent U.S. study [1] found 24.9% of adults to have a diagnosis of definite or suspected heart disease. This would suggest that there are two and one half million adult Canadians living with cardiovascular disease.

2. Canadian cardiologists became so concerned with this problem that they founded the Canadian Heart Foundation, with assistance from leaders of business and industry, government and the professions. It was incorporated under Part II of the Canada Corporations Act, effective June 1, 1956, "to co-ordinate and correlate the efforts of organizations and individuals interested in heart diseases with a view to reducing the morbidity and mortality therefrom in Canada".

3. The Canadian Heart Foundation is a federation of the six provincial Heart Foundations and of other organizations and persons devoted to reducing the toll of heart and blood vessel disease by the support of research and the dissemination of knowledge through professional

(1) Heart Disease in Adults - United States 1960-62.
National Center for Health Statistic Series 11 No. 6.
U.S. H.E.W. Public Health Service Publication No. 1000.

and public education. The six provincial Heart Foundations represent Quebec to British Columbia and in addition, there are four provincial divisions of the Canadian Foundation in the Atlantic provinces. In each there are chapters, committees and other local organizations that carry forward the work of the Heart Foundations.

4. The Canadian Heart Foundations are the only voluntary agencies in Canada concerned exclusively with heart and blood vessel disease. They raise their money by public subscription in the Canadian Heart Fund. Although some of the provincial Heart Foundations receive grants from their respective provincial governments, the federation receives no grants or money, directly from the Government of Canada.

5. The prime objective of the Canadian Heart Foundations is the prevention of cardiovascular disability and death. As knowledge to prevent cardiovascular disease is markedly deficient at this time, the Heart Foundations devote over 70% of their expenditures to the seeking of this vital information through the support of research. They do not undertake research within their own institutions, but have supported, by over $15,000,000, that done in the universities and hospitals of this country in the past ten years.

6. Heart Foundation support of research takes two forms. The first consists of the support of persons in research training or at post-doctorate levels. This constitutes the fellowship programme. The second form is grants-in-aid of research which do not pay a stipend to the principal investigator, but provide him with money for professional assistance, technical help, equipment and expendibles essential to the conduct of his research programme. For either fellowship or grant-in-aid, applications are made on the prescribed forms. Since applications for funds exceed the funds available, a selection has to be made. This selection is made on a competitive basis by peer groups composed of persons from the staffs of Canadian universities representing the various disciplines involved. In this way,

a research proposal is judged by peers from several different institutions, individually and collectively. The monies awarded are placed with the institution where the work is to be carried on, to be administered by the institution on behalf of the awardee. To the junior Fellows, who are regarded as persons in training, the money may be awarded directly.

7. The Canadian Heart Foundation is particularly proud of its system of review which has now been adopted by such government agencies as the Medical Research Council and the Department of National Health and Welfare in its Public Health Research Grants programme. The Heart Foundation was the first to institute the "external" (individual) plus "internal" (group) review programme with panels of university or other experts chosen by discipline. All applications are subject to two levels of assessment, one on a national scientific basis and the other may introduce geographic, or jurisdictional considerations. The composition of the panels changes regularly with a term of three years for any one member. Fresh points of view are introduced each year and the programme does not become entrenched and rigid.

8. Through their scientific activities, the Heart Foundations are working hopefully, to put themselves out of business, by the solution of the problems of cardiovascular disease.

Recommendation

9. 1. The Canadian Heart Foundations believe that all levels of government should take cognizance of cardiovascular disease, Canada's number one health problem, and that each government should take actions that are consistent with its solution.

B BIOMEDICAL SCIENCE

10. It has been stated [2] that "Nowhere are Canadian research contributions more apparent than in the field of cardiovascular surgery". Listed are such advances as the introduction of heparin in surgery,

(2) Canadian Medical Research: Survey and Outlook.
MRC Report No. 2 - 1968, Page 295.

the first use of human heart valves, the closure of heart defects, the development of hypo-thermia and of internal mammary artery transplant, the development of the first heart pacemaker and electrical shocking of the heart to correct abnormal rhythms. These innovations have resulted from very modest expenditures in Canadian scientific activities in the biomedical sciences since the Second World War.

11. The biomedical sciences include basic biology and the health sciences. They comprise a very broad group of studies ranging from the fundamentals of life in the D.N.A. molecule to the development of prototype procedures and devices, or to the study of large population groups in animal or human ecology. The studies may be of many kinds, involving aspects of the physical, life and human sciences.

12. The great part of Canadian research in the biomedical sciences is performed in the universities, or their associated hospitals. The health sciences in the university, in addition to responsibility for care of the sick, have the special responsibility for research and teaching. An atmosphere and forum in which the creative activities of students and staff can be encouraged is essential. In this way, the enthusiasm and ideals of the younger people can be joined with mature expertise and experience, for innovation in community health assessment, delivery and care.

13. In biomedical sciences, teacher-scientists are also practitioners of a service to the public in many instances. The same person may be engaged in a most fundamental research problem in the morning, an applied or developmental problem in the afternoon and practising his art in the evening or on weekends. In this way, there is little possibility for the sequestration of knowledge, because it may be applied by the same person, the same day.

14. The great advances that have been made in the biomedical sciences make great demands on the practitioners in these fields because they must be constantly renewing their body of knowledge. An enquiring attitude must be developed by the students of these disciplines, in addition to the intellectual and manual skills, to a degree not required in many other occupations, in which the rate of change in knowledge is less rapid. The imagination and stimulation of university teacher-scientists are paramount to the well-being of biomedical sciences.

15. The number of investigators required by Canadian medical schools alone will be 2,596 by 1972-73 according to the M.R.C. Report No. 2, quoted above. To this number must be added the dental, pharmacy, nursing and other requirements in Canadian universities for biomedical scientists. Where will they come from?

16. The Association of Canadian Medical Colleges has shown that there were 1,352 graduate degrees in the medical sciences awarded in Canada between 1946 and 1964. One-third of these persons are now in the United States or elsewhere, 30% joined the teaching faculties of Canadian universities, and 26% were absorbed by industry and government. On interview of a sample of those in the United States, it was learned that it was the academic climate in Canada that often was a primary consideration in their failure to return to Canada. The climate is, among other things, a function of the degree to which the faculty is found stimulating, and this is partly a function of the funds available for research.

17. The dollar requirements of individual fellowships or grants in the biomedical sciences are seldom over five figures. In the aggregate, they are less than $50.000,000 at the present time. This expenditure is surprisingly productive of knowledge, trained man-power and visible social benefit.

18. Support in the biomedical sciences can yield greater social dividends than in many other fields. The cost of producing one Ph.D. in astrophysics has been estimated by Dr. Harvey Brooks [3] as $500,000 (U.S. Fiscal 1963). For molecular physics the estimate was $93,000, and for chemistry, it was $39,000. The average cost of a Ph.D. degree in the biomedical sciences in Canada today, probably would not exceed $50,000. Thus, the amount of money spent to produce one Ph.D. in astrophysics can produce ten in the biomedical sciences. While Canada has need of all kinds of scientists, our position as a voluntary health agency requires that we emphasize the needs of biomedicine.

19. The Government of Canada is committed to extended health care for Canadian citizens. The training facilities are being expanded and staff recruited. The ensure the acquisition and retention of the staff and of graduate students in the numbers required, adequate research funds will have to be provided.

20. In addition, more efficient deployment of the present health professionals would seem most desirable. Their roles will undoubtedly change, and much greater emphasis will be given to the preservation of physical and mental well-being. The Medical Assistant Programme at Duke University and other similar programmes at various stages of development may help to ease the present shortage of the providers of health care.

Recommendations

21. 2. Biomedical research and development support is critical to the attainment of the personal health, prosperity and the leisure goals of Canadians. It must be given a

(3) Science Policy and the University. The Brookings Inst. 1968, Page 74.

higher priority to permit it to increase rapidly to a level of government expenditure appropriate to the goals of a leading industrial country.

22. 3. The actual disposition of funds for the support of scientific research and development in the biomedical sciences should be primarily in Canadian universities and their associated colleges and hospitals.

C THE VALUE OF SCIENTIFIC ACTIVITIES IN CANADIAN UNIVERSITIES TO CANADA

23. The Canadian Heart Foundation endorses the six National Goals identified by the Science Council in Report No. 4. It would emphasize that the contributions of Science and Technology for the goals of Health and of Education are one, in the biomedical scientific activities of the universities.

24. In the university, research and education are inseparable. It is only by having academic staff at the frontiers of knowledge that students can be stimulated appropriately. To quote A. N. Whitehead in "Universities and Their Function" (4)

> "Do you want your teachers to be imaginative? Then encourage them to do research. Do you want your researchers to be imaginative? Then bring them into intellectual sympathy with the young at the most eager, imaginative period of life, when intellects are just entering upon their mature discipline. Make your researchers explain themselves to active minds, plastic and with the world before them; make your students crown their period of intellectual acquisition by some contact with minds gifted with the experience of intellectual adventure. Education is discipline for the adventure of life; research is intellectual adventure; and the universities should be homes of adventure shared in common by young and old.

(4) Universities and Their Function in the Aims of Education. A. N. Whitehead - The New American Library.

For successful education, there must always be a certain freshness in the knowledge dealt with. Knowledge does not keep any better than fish."

The development of the proper attitudes for learning and for critical skills must be gained in university, if not theretofore, because their chance of being acquired later is minimal. It is only in this way that professionals will be able to accept and discharge responsibility for their own education on a continuing basis.

25. With the dual responsibility for research and education, it is unfortunate that the universities in this country have, in the main, organized their departmental establishments largely on the basis of the teaching load. Yet, they often make appointments to, and promotions within, departments on the basis of scientific creativity, or research. They are clearly dependent upon research activity and its interactions though they too often look upon it as an activity outside the scope of the university budget.

26. The relation of the university and of its research and educational capacity to the community is a vexed question. Dr. Clark Kerr, in his book "The Uses of the University" has stated that "Knowledge Production" is growing at about twice the rate of the rest of the economy. The knowledge-industry is going to serve as the focal point for national growth in the second half of this century. Dr. Kerr believes that the university, to respond to the expanding claims placed upon it, must merge its activity with industry and establish new intellectual currents. The "multiversity", he claims, has become the servant of the government and industry. Surely this is a false premise and it has found only limited acceptance.

27. Professor J. K. Galbraith has held (5) that:

(5) The New Industrial State. J. K. Galbraith. The New American Library, Inc. Edition. 1968, page 379.

"The college and university community must retain paramount authority for the education it provides and for the research it undertakes. The needs of the industrial system must always be secondary to the cultivation of general understanding and perception. Similarly, support for research and scholarship must be in accordance with some natural distribution of human curiosity and competence. It will be urged that this is a counsel of perfection. It is, and it suggests how readily we assume that education and research must be subordinate to the needs of the industrial system. But they need not be subordinate if it is realized that the educator is a figure of power in this context. He is the source of the factor of production on which industrial success depends; he must realize this and exert his power, not on behalf of the industrial system but on behalf of the entire human personality."

28. Galbraith can only logically refer to relatively small expenditures for individual scientific activity, usually on campus. But there may also be very large capital or operating expenditures in certain scientific studies, as suggested above, still closely linked to academic institutions. The magnitude of these expenditures require that they be funded almost entirely by government. The cost and benefit of such ventures must be carefully assessed and compared with similar analysis of the competing items and programmes for support. Care and foresight are needed to preserve the independence of the universities in education and research and, at the same time, to have them play additional and needed roles in relation to industry and the community at large.

Recommendations

29. 4. The Government of Canada should devise broader consultative procedures, with greater involvement of the academic community, in the allocation of funds to the

various sectors of scientific research and development associated with Canadian universities.

30. 5. The systematic review of all such allocations of funds towards scientific activities in the universities, whether capital or operating, should relate to national goals and be on the basis of national competition and of examination by scientific peers.

31. 6. The role and independence of the academic community in education and research must not be compromised by excessive demands for additional service functions in the community--particularly if these can be satisfied by other mechanisms, or by the awarding of grants or contracts to the universities that deal with classified material, except in times of national emergency.

D RESEARCH AND DEVELOPMENT IN CANADA

32. The Canadian Heart Foundation, by its special competence in a relatively narrow field, is not in a position to comment in detail on all aspects of the Orders of Reference. It accepts the O.E.C.D. Report [(6)] that, "In proportion to the gross national product, expenditure on research and development in Canada is less than half that obtaining in the United Kingdom or the United States. While the validity of this particular comparison may be questionable, it is one which Canadians themselves frequently make. There is no question, however, that an investment of less than one per cent of the GNP in activity as important as research is abnormally low for a country as prosperous and with as well-developed an industrial sector as Canada". Dr. Omand Solandt has stated that scientific research and development spending in Canada could rise to four per cent of the GNP.

(6) Training of and Demand for High-level Scientific and Technical Personnel in Canada. O.E.C.D. Paris 1966 - Page 133.

33. Dr. B.G. Ballard stated, in the Brief of the Canadian Patents and Development Limited, before this Committee on October 31, 1968, that "It is a broad generalization that for every dollar expended in the research phase of a project, ten more dollars (sometimes much higher) will be required to carry it through the development phase; and perhaps an additional hundred dollars will be needed to set up for commercial production and to market it".

34. Specific examples of the composite nature of research development and innovation have been reported in a recent study (7). It traces in retrospect, the key events that lead to five recent, socio-economically important technological innovations. Of the events, approximately 70% were non-mission research, 20% were mission oriented, and 10% were development and application. Non-mission research peaked between two and three decades prior to innovation, and was 90% complete 10 years before innovation occurred. However, some non-mission research was essential even in the final decade before innovation. The distribution of key events by three classes of performers was as follows:

	University & College	Research Inst. & Gov. Laboratories	Industry
Non-Mission Research - motivated by the search for knowledge.	76%	14%	10%
Mission-oriented Research - performed to develop information for a specific application.	31%	15%	54%
Development and Application - prototype development and engineering design.	7%	10%	83%

35. This study provides interesting data and a commentary on epistemological questions that have been raised about the very nature of the research process and of its direct contribution to the welfare

(7) Technology in Retrospect and Critical Events in Science (Traces) prepared for the National Science Foundation. The Illinois Institute of Technology Research. Vo. 1, 1968.

of society. It demonstrates the importance of interdisciplinary communication and the need for a better understanding of the two-way interaction between science and technology. Clearly, also -- innovations for future generations depend on today's fundamental research.

36. But how does this relate to Canada? The Economic Council has indicated "that the capacity for Canadian business management to undertake successful innovation be strengthened". Dr. C.M. Isbister, before this Committee, inferred that there is need for a freer interchange between scientists in the employ of the government and those in the university. The same might be said of the scientist in industry. Some exchange of information occurs now. A more ready exchange of personnel, would be of advantage to all groups, and might speed innovation. Perhaps a leave of absence without loss of seniority or fringe benefits could be an effective means of encouraging the exchange of the human resources between these three performers in R & D.

37. The Science Council has proposed National Goals that are commendable, but they are interdisciplinary, as are the various programme activities, fields of planning and areas of consideration that it has outlined. The need for much freer communication and exchange in all scientific activity in Canada is again emphasized.

38. Canada has scientific and technological skills that can be shared with less fortunate nations and peoples. She is highly industrialized, and is accepted as being without imperial design. She is welcomed in many parts of the world that are closed to other powers. There may be opportunities to emphasize those skills in which she has special competence, working with local groups, and using the co-operative experience gained through A.R.D.A. and similar assistance plans. Shared programmes for common social goals can possibly be most effective if operated through

United Nations agencies, and not constrained by a fixed percentage of cost to be expended in Canada.

Recommendations

39. 7. The Government of Canada should create new arrangements for the stimulation of industrial research, development and innovation in Canada. These arrangements may take many forms. Government contracts and grant proposals to industry should be subject to a similar type of external critical appraisal as the support programmes for academic research, and reviewed periodically by the institution of a systematic technical assessment.

40. 8. Appropriate supply and distribution of properly qualified manpower in Canadian scientific activities can be assisted by the development by the Canadian Government of an information bank of scientific manpower. In addition, the mobility of personnel between producer and consumer, between Canadian academic institutions and Canadian governments and industry, and with co-operative programmes abroad, should be facilitated.

E GOVERNMENT ORGANIZATION FOR CANADIAN SUPPORT OF RESEARCH AND DEVELOPMENT

41. The Canadian Heart Foundation is grateful that the Honorable Senator Lamontagne spoke with concern of the need for a Science Policy for Canada in his maiden speech on June 29, 1967. His initiative brought attention to the lack of co-ordination between some of the allocations to scientific activity. This Senate Committee is to be complimented for the creation of a forum on science policy in which all citizens and organizations are invited to present and explain their points of view. If there is one major factor that has contributed to the present confused aims and uncertain state of support of these essential activities, it

would seem to be the lack of adequate communication between the multiple authorities and various concerned parties. Of necessity, decisions affecting scientific activity may have been made by the Privy Council without sufficient examination of the likely consequences to all concerned.

42. For many years, the National Research Council was the only formal advisory body to the Committee of the Privy Council on Scientific and Industrial Research. When expenditures were comparatively small, this arrangement worked very well. The situation, however, has become more complex. The Privy Council Committee also has an Advisory Panel on Scientific Policy composed of Deputy Heads. N.R.C. is now directed primarily toward the natural sciences and engineering, while the Privy Council Committee does not represent all the federal departments undertaking scientific activities. In addition, the provincial governments have established research councils, foundations and other agencies to meet their particular requirements.

43. Until the Science Secretariat was formed within the Privy Council Office to advise the Cabinet and its committees, considerations were of an inhouse nature, and were not particularly aggressive towards scientific affairs. The Secretariat has attempted to identify scientific and technological issues at home and abroad. The Science Council has carried these considerations a stage further and has authorized a number of Special Studies. Some of these have already been published and upon certain of them, it has reported with recommendations. These Special Studies are, in effect, inventories of present personnel and facilities with modest projections for requirements in the next five to seven years. There is some disparity in the approaches that have been taken to the particular fields under study. The results are not likely to be of uniform value. A catalogue of Canada's

human resources and physical facilities is essential to the consideration of policy and planning.

44. The many and increasing demands upon the public purse, required that a selection be made for the expenditure of government funds at any point in time, embracing all government programmes. A selection must therefore be made for government expenditures in scientific activities. The creation of a Science Policy for Canada is essential to the establishment of priorities for government expenditure in the various sectors in scientific research, development and innovation. Such priorities can be purposeful and in the national interest only if they are congruent with national and international scientific objectives.

Recommendations

45. 9. Canadians must establish clearly defined national and international objectives in scientific affairs.

46. 10. The Government of Canada should create a mechanism for the co-ordination of science policy, and for the participation of informed and concerned citizens in the development and continuation of science objectives. The Special Committee of the Senate on Science Policy has initiated this process. It should continue as a Standing Committee of the Senate, and maintain a public forum for discussion. Moreover, it is suggested that the Science Council should invite submissions from citizens and groups before recommending objectives in scientific affairs for Canada.

47. 11. There should be a systematic and open review of these objectives, and of the publicly declared projections by which they will be reached.

48. 12. A set of priorities for Government of Canada expenditure on scientific research, development and innovation should be established and systematically reviewed. The priorities

may change, but they must be consistent with the published objectives in scientific affairs, and with their anticipated projections over several years.

49. It is not advisable that there should be a federal Department of Scientific Affairs. Such a department would take away from existing Departments (of Agriculture; Communications; Energy, Mines and Resources; Fisheries and Forestry; Indian Affairs and Northern Development; Labour; Manpower and Immigration; National Defence; National Health and Welfare; etc.) the special competence and initiative each has developed. Such a proposal would constitute a departmental "brain-drain". Other devices to centralize science policy and effort are possible.

50. It is not advisable that there should be a Minister of Science Affairs without a Department. He would exercise no authority in Cabinet without departmental responsibility and budgetary control.

Recommendations

51. 13. Each Department and Agency of Government should have the obligation to undertake a programme of operational research to review its own programmes and the ability to innovate at the appropriate time.

52. 14. Those Departments or Agencies that have extensive intra-mural research and development programmes should have advisory panels of non-government as well as government persons, on whom they can call.

53. The President of the Treasury Board must, by the nature of his office, be a neutral force in Board discussion of Government expenditure. There is an inherent conflict of interest when he is also Chairman of the Privy Council Committee on Scientific and Industrial Research, which is the ultimate decision making body in scientific affairs, acting upon the priorities presented.

Recommendation

54. 15. The Chairman of the Privy Council Committee on Scientific

and Industrial Research should be other than the President of the Treasury Board. The Chairman of a Senate Standing Committee on Scientific Affairs would be a most satisfactory Chairman of this important Committee.

55. The Canadian Heart Foundation feels strongly, as does Dr. Alexander King, Director for Scientific Affairs, OECD, that "the decision of the National Research Council to devote a large part of its funds and energy to building up science in Canadian universities has undoubtedly been the right approach". This pattern has been adopted and should be continued by the Medical Research and Canada Councils.

56. In this vast country, what might be lost in efficiency by the lack of very large central laboratories, is more than offset by the development of local enterprise and competence, and by a more general awareness of science in many communities. There is a tendency for the larger centres to attract scientists away from the less well-endowed ones that can only be negated by building up science in as broad a way as possible.

Recommendation

57. 16. All government Agencies and Departments making funds available for the support of scientific activities in Canada should take regional disparities into account. There is a need for what might be considered "seed funds".

58. The Education Support Branch of the Department of the Secretary of State has published recently [8] a list of some 66 Departments and Agencies of the Canadian Government that support research activity in the academic community. It is not known to this Foundation, how many of these have intra-mural programmes for the support of scientific activities. Nevertheless, the recommendations made in paragraph 30 regarding all allocations towards scientific activities should apply.

(8) Federal Expenditures on Research in the Academic Community 1966-67, 1967-68. Education Support Branch, Department of the Secretary of State. Report No. 1. 1968.

Recommendation

59. 17. The intra-mural expenditures on scientific activities of Government Departments and Agencies should be subject to a similar periodic external peer assessment and review, as the academic and industrial support programmes.

60. The recommendation of paragraph 59 may put the extra-mural grant applicant in the unpleasant position of "biting the hand that feeds him". As noted in the report of the Study Group under Dr. John B. MacDonald [9], Special Study No. 7, the scientists outside a Government Department or Agency, who are the recipients of NRC grants, and who are also asked to sit in judgement on the NRC Intra-Mural Programme, may find it difficult "to evaluate objectively the laboratories of the agency which supports their research".

Recommendation

61. 18. The Extra-Mural Support Programme of the National Research Council should be separated from the Intra-Mural Programme by dividing these two functions between two separate agencies though both reporting to Cabinet through the Chairman of the Privy Council Committee. Should the Extra- and Intra-Mural Programmes for the support of scientific activities of any other Department or Agency reach a similar magnitude, the same recommendation would apply.

62. Continuing public discussion by means of a national forum is essential for the creation of a viable science policy for Canada, to establish and review government priorities for "Planning, Programming and Budgeting" in scientific activities.

63. The Canadian Heart Foundation is grateful for this opportunity to express its views and hopes that this Committee will agree to a formal structure for the continuation of public dialogue through an arm of the Parliament of Canada.

CANADIAN HEART FOUNDATION INCORPORATED JUNE 1956

270 LAURIER AVE. WEST, OTTAWA 4, CANADA

EXECUTIVE DIRECTORS: JOHN B. ARMSTRONG, M.D. (MEDICAL)
E. McDONALD (ADMIN.)

PATRON
HIS EXCELLENCY THE RIGHT HON. ROLAND MICHENER, C.C., C.D.
GOVERNOR-GENERAL OF CANADA

PRESIDENT: J.B. WEDGE, Q.C., SASKATOON

August 18, 1969

The Honourable Maurice Lamontagne, P.C.
The Senate
Ottawa, Canada.

Dear Sir,

It has been suggested to me that, on behalf of the Canadian Heart Foundation, I might submit supplementary material to the brief of this Foundation, which was received too late to be presented at a public meeting of the Special Committee on Science Policy. Some of the points that might have arisen in the question period are enumerated below.

1. The constituency of the Canadian Heart Foundation is 75,000 volunteer workers in all twelve provinces and territories, serving many committee functions in more than 950 communities in Canada. As shown in the financial statements of the enclosed Annual Report, the public of Canada demonstrated its confidence in Heart Foundation activities by support of the Heart Fund to the extent of $2,101,000. This sum represents over 800,000 individual donations.

2. This brief would have been presented to your Committee by:

   Dr. David R. Murphy, Surgeon in Chief, The Montreal Children's Hospital; Professor of Surgery, McGill University
   Chairman, Medical Advisory Committee, Canadian Heart Foundation

   Dr. Aurele Beaulnes, Professor of Pharmacology, McGill University
   Chairman, Medical Advisory Committee, Quebec Heart Foundation

Dr. Gardner C. McMillan, Visiting Scientist and Special Assistant to the Director, National Heart Institute, U.S. Public Health Service
Chairman, Scientific Subcommittee, Canadian Heart Foundation

Dr. John B. Armstrong
Executive Director (Medical), Canadian Heart Foundation.

The curricula vitae of these persons are attached. That of Dr. McMillan was not submitted with the original copy of the brief.

Preparation of this brief was the responsibility of the above named, although the actual writing was done by myself.

3. The Canadian Heart Foundation has been thought of as a communications bridge, bringing the aspirations and concerns of the community to the scientists, and vice versa. It is composed of citizens especially informed in particular fields, and can assist in bringing the concerns of the public to the attention of the decision makers of government, commerce and industry, and in the transmission of information in the opposite direction for the general good. The late Dr. R. F. Farquharson, former chairman of the Medical Research Council, stated that the Heart Foundation's influence in Canada far exceeded the sums by which it has supported research activity in Canadian academic institutions.

4. The burden of the Heart Foundation's brief is a plea for more participation by the informed and concerned citizens of Canada in the development of national and international scientific objectives, an open and systematic review of these objectives, and for a set of priorities to be established for Canadian Government expenditure on scientific research, development and innovation consistent with the published objectives and with the anticipated projections over several years.

5. The Special Senate Committee on Science Policy should continue as a Standing Committee of the Senate, to establish a continuing locus for government and public concern for

Canadian scientific activities. The Chairman of this Senate Standing Committee on Scientific Affairs would be a most satisfactory chairman for the Privy Council Committee on Scientific and Industrial Research.

6. The advances made through research and development in Canadian government laboratories are many. In the cardiovascular field, mention might be made of the defibrillator and pacemaker, and the mechanical stapler for fine vessel surgery. This Foundation believes that the benefits of modest research expenditures in Canada in this field have been considerable, because the health professions throughout the world are using many of the techniques and treatments developed here.

The rates of government expenditures on Biomedical Research and Development, and General Expenditures on Research and Development in Canada compared with the United States, for 1968, may be tabled as follows:

Government Expenditures - 1968

	Biomedical R & D	GERD	GNP
Canada	$50M[2]		
	5%	$1.0M[3]	
	0.075%	1.5%	$67M[3]
U.S.A.	$2.5M[3]		
	10%	$25M[3]	
	0.3%	3.0%	$850M[3]

7. A list of the research grants and fellowships awarded by the Canadian Heart Foundations for the year 1969-70 is attached for your information. Over $2,500,000 was awarded from applications that, in total, were over $3,250,000. As indicated in the brief, selection is made on a competitive basis by peer groups. For ease of reference, a copy of the brief is also attached.

The French version of this brief has been delayed but will be sent to you and to the Secretary of the Committee as soon as it is available.

The Canadian Heart Foundation does appreciate the granting of this opportunity to expand upon its views regarding the formulation of a Science Policy for Canada.

Sincerely yours,

John B. Armstrong

John B. Armstrong, M.D., F.R.C.P. (C)
Executive Director (Medical)

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APPENDIX 196

BRIEF TO THE SENATE SPECIAL COMMITTEE

ON

SCIENCE POLICY

BY THE

CANADIAN ASSOCIATION OF CHIEFS OF POLICE, INC.

MARCH, 1969

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ON

SCIENCE POLICY

BY THE

CANADIAN ASSOCIATION OF CHIEFS OF POLICE, INC.

A. SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

(I) Economic losses due to criminal activities in Canada cannot be reckoned with any marked degree of precision, but would most certainly, if it were possible to ascertain, reach into millions of dollars annually. However great this may appear, the value pales into insignificance when compared to the value of those basic political, social and religious institutions and freedoms upon which our nation is founded and which the total Canadian law enforcement community is charged to protect and preserve. The formulation of a national science policy without due regard to standing and future urgent needs in the realm of law enforcement science and technology, would therefore be a deplorable mistake.

(II) While scientific and technological support is an integral and vital necessity for the efficiency and effectiveness of Canadian law enforcement, its practical availability at the operational level (except under emergency conditions) tends to arrive for the most part as a make-do spin-off from other scientific activities rather than as the tailored outcome of a planned and organized support for the development of law enforcement aids.

(III) No scientific body in Canada appears obliged to provide other than emergency assistance, or to provide

special staff and funding, or to devote an appropriate amount of time and effort in the continuing support of law enforcement bodies. Assistance of such organizations as the National Research Council of Canada must be sought in competition with its other priorities. There is in fact no properly constituted advisory group in Canada to which one may appeal for guidance in the total needs of Canada's law enforcement community, let alone the determination of priorities in relation to other national needs, appropriate levels of effort, funding, and long term plans for essential research and development.

(IV) Other advanced nations that are faced with the challenge of today's organized crime, the growth of civil unrest, the demand for penal reform, the burgeoning needs of modern police and security communications systems, etc., have faced up to the need for organizational restructuring in order to combine the facility to study with the facility to act. Reference is here made to the Home Office Scientific Council of the United Kingdom, whose function it is to advise the Home Secretary on scientific research for the police service including forensic science. In the United States the Law Enforcement Assistance Act was introduced to provide a vehicle for introducing new resources and fostering the development of new and existing law enforcement capabilities in every facet of the problem.

(V) In view of the foregoing circumstances, it is recommended that an appropriately constituted Canadian council of law enforcement science and technology be constituted as a matter of national urgency, and charged with tasks to include at least the following:

(V) (i) To carry out a review in depth of the organizational preparedness of the total Canadian law enforcement community to meet current and future needs in the art and science of law enforcement.

(V)(ii) To review Canadian Departmental responsibilities, capabilities, and activities in the evaluation of requirements in law enforcement science and technology, with particular reference to the innovation and support of research and development work, the feedback and evaluation of requirements from the operational level; channels of national co-ordination; funding and long range planning of research and development requirements.

(V)(iii) To establish a special study group to examine current and future needs for the acquisition, sorting, storage, analysis, retrieval and distribution of law enforcement information with particular reference to the need for a national computerized communication and information net, together with a priority rating in relation to competing demands for satellite communications space.

(V)(iv) To consider the need for interdisciplinary studies of forensic science with particular reference to the development and evaluation of new scientific tools and techniques, and their introduction into courts of law.

(V)(v) To review the adequacy of police training facilities in present day technological perspectives, and to consider a national policy for the provision, support, maintenance and utilization of regional training centre facilities.

(V)(vi) To review the problems of law enforcement in relation to social and political evolutionary trends with reference to civil rights, organized crime, civil unrest, questions of surveillance, and developing areas such as psychological aids to interrogation.

(V)(vii) To review the need for the development of international co-operation and participation in law enforcement science and technology.

(V)(viii) To consider means for obtaining the support of academic and scientific institutions, such as, the criminology departments of the University of Montreal, University of Toronto, University of Ottawa, and permanent government departments such as the National Research Council.

(V)(ix) Among other things to study means of developing:

(a) through the use of computers and other sophisticated equipment, rapid methods of searching and identification of fingerprints, particularly latent fingerprints;

(b) improved methods of radio communication, for example, personal radios for police officers, and miniature or pocket-type recorders for field interviews;

(c) improved surveillance equipment;

(d) equipment which will automatically pinpoint the location of police vehicles;

(e) improved alarm and intrusion detection devices for the purpose of preventing crime;

(f) non-lethal aids for the use of the police to quell mob disorders without effecting injury to the participants.

****

B. INTRODUCTION

1. This Brief is submitted by the Canadian Association of Chiefs of Police, Inc., a body formed in the year 1905 and incorporated on March 26, 1968, under Part II of the Canada Corporations Act, and whose objects are, namely:-

(a) to encourage and develop co-operation of all Canadian police organizations and their members in the pursuit and attainment of their common objects;

(b) to create and develop the highest standards of efficiency in law enforcement through the fostering and encouragement of police training by education and research;

(c) to promote and maintain a high standard of ethics, integrity, honour and conduct in the profession of law enforcement;

(d) to encourage and advance the study of modern and progressive practices in the prevention and detection of crime;

(e) to foster the uniformity of police practices and co-operation for the protection and security of the people of Canada.

2. The membership potential of this organization represents the senior police administrators of 652 municipal police forces, the Quebec Provincial Police, Ontario Provincial Police, Canadian National Railways and Canadian Pacific police forces, National Harbours Board Police and the Royal Canadian Mounted Police. There are 215 senior police administrators included in the current roster as active members in good standing, in addition, there are 23 associate members, 11 honorary members and 107 life members.

3. It goes without saying that the incumbent Board of Directors of this organization not only speaks for this membership at large but is the only organized voice through which their views and those of the authorized strength of 43,724 personnel of police departments of Canada may be represented.

4. In spite of the Association's limited financial resources and without the benefit of a full-time secretariate over the years it has continued its function quite successfully, and more particularly so in recent years. At its Annual Conferences it has brought together police administrators from across Canada for discussion and study of subjects related to the total picture of effective law enforcement. Without the Association there would not be the creation of uniform standards and investigation techniques, the co-operation and co-ordination so necessary in this technologically oriented society with its ever increasing crime, and in particular, organized crime.

5. The Association has accomplished many things, examples are:

- the central repository of criminal records based on the infallible technique of fingerprint identification in the year 1911;
- changes in the Criminal Code of Canada, other federal statutes and provincial acts;
- the retention of serial numbers on motor vehicle chassis, engines and transmissions for the purpose of identifying and tracing stolen automobiles and component parts;
- a Brief to the Canadian Committee on Corrections in the form of answers to questions asked in connection with law enforcement, administration of justice and corrections;

- a Brief to the Royal Commission on Security;
- a Brief to Judge R.A. Sargent's Commission in Vancouver, B.C., on the Invasion of Privacy by Technological and Electronic Devices;
- the distribution of a detailed police training manual to over 250 police forces in Canada with the co-operation of the Metropolitan Toronto Police;
- a Brief and appearance before the House of Commons Standing Committee on Justice and Legal Affairs on a private Member's Bill C-115, an Act to amend the Criminal Code (Destruction of Criminal Records);
- in collaboration with the Dominion Bureau of Statistics developed and implemented a uniform crime reporting statistical system for Canadian police forces covering police administration, crime and traffic enforcement;
- at the request of the Solicitor-General submitted a detailed critique on proposed amendments to the Juvenile Delinquents Act;
- recognizing the threat of organized crime, developed the initial police liaison and communication procedures, and continues to deal with the problem;
- actively participated in the development of the Canadian link with the National Crime Information Centre (computerized exchange of criminal activity information) at Washington, D.C., through the Royal Canadian Mounted Police.

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6. On the occasion of the need for a formal presentation and hearing of this Brief, should the Honourable Members of the Special Committee so desire, it can be arranged through the Secretary-Treasurer of the Canadian Association of Chiefs of Police.

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C. LAW ENFORCEMENT, SCIENCE AND TECHNOLOGY

7. In March, 1967, the First National Symposium on Law Enforcement, Science and Technology under the sponsorship of the Office of Law Enforcement Assistance, United States Department of Justice and the Law Enforcement Science and Technology Centre, Illinois Institute of Technology, Research Institute, Chicago, Illinois, was held.

8. The purpose of the Symposium was to stimulate the application of science and technology to the areas of Criminal Justice, Law Enforcement, Courts and Corrections by: providing an annual professional forum for the exchange of ideas and information, identifying the relevant capabilities of science and technology; fostering communication between justice and science and engineering communities; publication of proceedings.

9. The fifty police officers from Canada attending the Symposium along with about 1500 police officers from the United States came away with a new outlook on the inter-relationships possible in such an exchange of ideas.

10. Possibly the thing that struck most of the Canadians was why do we have to turn to the United States for forums such as this?

11. Later on in 1967, another Symposium was held in New York City where the objectives were twofold: to inform a mixed professional audience of the state-of-the-art in the application of science and technology in

dealing with crime and criminals; to highlight the principal problems to which science and technology are relevant and thereby stimulate the listeners to either personal or professional involvement in their solution.

12. In July, 1967, the Canadian Association of Chiefs of Police, Inc., wrote to Dr. O.M. Solandt, Chairman, Science Council of Canada, raising the question of the possibility of holding a Canadian Symposium where police officers of Canada would meet with the science and technology communities to review the problem of law enforcement and discover new methods of combatting them.

13. Dr. Solandt replied in part as follows on August 11, 1967:

> "There is no doubt that a great need exists to try to bring the resources of the scientific community to bear on helping in the problems of law enforcement."

14. Dr. Solandt subsequently arranged a meeting on our behalf with Dr. W.G. Schneider, President, National Research Council, Ottawa, on January 9, 1968, with representatives from the Canadian Association of Chiefs of Police being: Lt.Col. E.A. Spearing, M.B.E., President, Mr. D.N. Cassidy, Secretary-Treasurer, and Superintendent C.R. Eves, Officer in Charge, RCMP Laboratories.

15. Dr. Schneider was most interested in the concept of holding a Canadian Symposium to stimulate the application of science and technology to law enforcement.

16. Dr. Schneider suggested a steering committee be formed representing the police and the National Research Council.

17. The steering committee revealed there was some duplication between the symposiums held in the United States and meetings of scientific groups. Some of the applications of science, although interesting, were too sophisticated

for the average police department. What law enforcement needed and was looking for were new scientific and technological techniques to assist the police officer in his field duties of patrol and investigation, and not just laboratory applications. That some form of educational program was needed to keep the police informed of new scientific and technological developments which could be applied to their every day work, as well as new methods developed through scientific and technological research to assist law enforcement.

18. The question was how could the scientific and technological communities be encouraged to assist the police and law enforcement in general. No longer satisfactory was the current practice whereby police departments worked independently developing new techniques and where several police departments worked independently on the same projects and unknown to each other.

19. The steering committee reviewed the advances made in recent years in the United Kingdom and the United States to deal with the problems expressed in this Brief. The attention of the Honourable Members is directed to the work of the Office of Law Enforcement Assistance, United States Department of Justice (Appendix II) and the Home Office Scientific Advisory Council in the United Kingdom (Appendix III).

20. This Association strongly feels there must be a means developed in Canada to deal with problems confronting the police and which are of real concern to society. The public must be made aware of what is required so that public opinion will accept new techniques used by the police. There is a real need for an advisory council representing such areas as legal, sociology, medicine,

science and other disciplines. Through an advisory council government, education institutions and industry would be influenced to develop new scientific and technological methods to assist law enforcement. At the moment the police group is a voice crying in the wilderness.

21. As recent as December 10, 1968, Senator Edward M. Kennedy called on Americans to forge new skills of science and technology into an all-out attack on crime. He said "there is no reason why 20th century police, courts and prisons should be shackled with 19th century methods."

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22. The primary purpose of this brief is to draw attention to areas of basically scientific and technological problems that are facing the law enforcement community, rather than to argue at this time the minutiae of corrective measures. Nevertheless, this Association is convinced of some specific means by which solutions may be brought about, but which of necessity demand to be brought about within a national frame of reference. It is conceded at the outset, of course, that one cannot deal with law enforcement entirely independently of a host of closely related political, juridical, and sociological problems. It is therefore hoped that the Honourable Members of the Special Committee will deal in the first instance with such of the following observations as fall within your immediate terms of reference; it is hoped in the second instance that you may, if not to accept the full recommendations of this Brief, at least be persuaded to act or make recommendations towards a more comprehensive review of the interacting political, juridical, sociological and technological forces involved in crime prevention, law enforcement and criminal justice.

23. The great difficulty in drafting an abstract of the very wide range of problems facing law enforcement agencies today, is in finding a place to start. We would like to begin with a short reference to Report Number One of the Ontario Royal Commission Inquiry into Civil Rights conducted by the Honourable James Chalmers McRuer, Chief Justice of the High Court of Ontario. That report reveals many circumstances that mitigate against the efficient administration of justice and many points of conflict between the observance of civil rights and the enforcement of law and order. There is one particularly important observation that is made concerning the machinery for the administration of justice which has its corollary in the machinery for law enforcement; that is the supra-regional concept of crime and responsibility. The Commission's vital comments may be extracted from pages 921 et seq., Chapter 60, Volume 2, as follows:

> "Is the administration of justice today truly a local matter? We think it is not. It is the view of this Commission that the entire Province benefits from the protection granted by the law and from its efficient administration, and likewise the entire Province suffers from its inefficient administration."
>
> "In the field of criminal law the crime is not committed against the municipality but against the State."
>
> "The administration of justice in its widest sense has passed from being something of merely local concern to a matter of general concern. The provision of adequate and proper facilities to efficiently and effectively administer justice is the common concern and right of every citizen of the Province."
>
> "Some municipalities are more affluent than others. The result has been that some communities are able to provide proper accommodation for the courts and jails, while in other communities, facilities are not only inadequate but such that they demean the administration of justice."

24. What is true for the administration of justice is equally true for the enforcement of law and order: crimes reflect on society beyond the local jurisdiction where they may be committed; crime organizations are not only nation-wide but have international connections; the problems and responsibilities for law enforcement are therefore supra-regional, nation-wide, and many facets are international in scope; it is predictable that disparities comparable to those found in the machinery for the administration of justice are to be found in the economic and technological support of law enforcement units in the towns, municipalities and rural areas across our nation.

25. The DBS in its report on Crime Statistics, 1967[1], the latest available, states there were 1,249,454 offences (excluding highway traffic offences) reported or known to the police in Canada under the Criminal Code, Federal Statutes, Provincial Statutes and Municipal By-laws. Upon investigation by the police, 59,247 or 4.7 per cent were unfounded.

26. Table I illustrates the number of actual offences and the percentage variation for the years 1962-67 inclusive:-

TABLE I

ACTUAL OFFENCES AND PERCENTAGE VARIATION 1962-67

Offences	Year	Number	Percentage Variation Over Previous Year	Percentage Variation Over Base Year 1962
Total - Canada	1962	796,675		
	1963	874,572	+ 9.8	+ 9.8
	1964	960,917	+ 9.9	+20.6
	1965	989,451	+ 3.0	+24.2
	1966	1,094,889	+10.7	+37.4
	1967	1,190,207	+ 8.7	+49.4
Criminal Code	1962	514,986	-	
	1963	572,105	+11.1	+11.1
	1964	626,038	+ 9.4	+21.6
	1965	628,418	+ 0.4	+22.0
	1966	702,809	+11.8	+36.5
	1967	786,071	+11.8	+52.6

cont'd

(1) DBS Crime Statistics, 1967

cont'd.

Offences	Year	Number	Percentage Variation Over Previous Year	Base Year 1962
Federal Statutes	1962	31,138		
	1963	26,677	-14.3	-14.3
	1964	33,791	+26.7	+ 8.5
	1965	30,382	-10.1	- 2.4
	1966	35,994	+18.5	+15.6
	1967	38,100	+ 5.9	+22.4
Provincial Statutes	1962	195,853		
	1963	219,288	+12.0	+12.0
	1964	248,772	+13.4	+27.0
	1965	271,857	+ 9.3	+38.8
	1966	290,096	+ 6.7	+48.1
	1967	296,504	+ 2.2	+51.2
Municipal By-laws	1962	54,698		
	1963	56,502	+ 3.3	+ 3.3
	1964	52,316	- 7.4	- 4.4
	1965	58,794	+12.4	+ 7.5
	1966	65,990	+12.2	+20.6
	1967	69,532	+ 5.4	+27.1

27. There were 554,852 persons reported charged by the police[2] in Canada during 1967 compared with 520,979 reported in 1966. The majority of persons were charged with Provincial Statutes offences (49.7 per cent) and Criminal Code (36.2 per cent) offences. (These data do not include persons charged with offences involving highway traffic and parking violations)[3].

28. The above data amply demonstrates the growth and seriousness of the crime situation in Canada and the very desirable need to bring the full impact of the scientific and technologicsl communities to bear upon this critical situation, in addition to other methods.

29. In the Summary to the Report by the President's Commission on Law Enforcement and the Administration of Justice "The Challenge of Crime in a Free Society"[4] 1967, the most recent and penetrating study of crime in the United States it is stated:

(2) DBS Crime Statistics, 1967
(3) DBS Traffic Enforcement Statistics, 1967
(4) The Report of the President's Commission "The Challenge of Crime in a Free Society" p. v and vi of Summary, February, 1967.

" Many Americans take comfort in the view that crime is the vice of a handful of people. This view is inaccurate. In the United States today, one boy in six is referred to the juvenile court. A Commission survey shows that in 1965 more than two million Americans were received in prisons or juvenile training schools, or placed on probation. Another Commission study suggests that about 40 percent of all male children now living in the United States will be arrested for a nontraffic offense during their lives. An independent survey of 1,700 persons found that 91 percent of the sample admitted they had committed acts for which they might have received jail or prison sentences.

Many Americans also think of crime as a very narrow range of behaviour. It is not. An enormous variety of acts make up the "crime problem." Crime is not just a tough teenager snatching a lady's purse. It is a professional thief stealing cars "on order." It is a well-heeled loan shark taking over a previously legitimate business for organized crime. It is a polite young man who suddenly and inexplicably murders his family. It is a corporation executive conspiring with competitors to keep prices high. No single formula, no single theory, no single generalization can explain the vast range of behaviour called crime.

Many Americans think controlling crime is solely the task of the police, the courts, and correction agencies. In fact, as the Commission's report makes clear, crime cannot be controlled without the interest and participation of schools, businesses, social agencies, private groups, and individual citizens.

What then, is America's experience with crime and how has this experience shaped the Nation's way of living? A new insight into these two questions is furnished by the Commission's National Survey of Criminal Victims. In this survey, the first of its kind conducted on such a scope 10,000 representative American households were asked about their experiences to the police, and how those experiences affected their lives.

An important finding of the survey is thhat for the Nation as a whole there is far more crime than ever is reported. Burglaries occur about three times more often than they are reported to police. Aggravated assaults and larcenies over $50 occur twice as often as they are reported. There are 50 percent more robberies than are reported. In some areas, only one-tenth of the total number of certain kinds of crimes are reported to the police. Seventy-four percent of the neighborhood commercial establishments surveyed do not report to police the thefts committed by their employees.

The existence of crime, the talk about crime, the reports of crime, and the fear of crime have eroded the basic quality of life of many Americans. A Commission study conducted in high crime areas of two large cities found that:

43 percent of the respondents say they stay off the streets at night because of their fear of crime.

35 percent say they do not speak to strangers any more because of their fear of crime.

21 percent say they use cars and cabs at night because of their fear of crime.

20 percent say they would like to move to another neighborhood because of their fear of crime.

The findings of the Commission's national survey generally support those of the local surveys. One-third of a representative sample of all Americans say it is unsafe to walk alone at night in their neighborhoods. Slightly more than one-third say they keep firearms in the house for protection against criminals. Twenty-eight percent say they keep watchdogs for the same reason.

Under any circumstance, developing an effective response to the problem of crime in America is exceedingly difficult. And because of the changes expected in the population in the next decade, in years to come it will be more difficult. Young people commit a disproportionate share of crime and the number of young people in our society is growing at a much faster rate than the total population. Although the 15 to 17 year-old age group represents only 5.4 percent of the population, it accounts for 12.8 percent of all arrests. Fifteen and sixteen year olds have the highest arrest rate in the United States. The problem in the years ahead is dramatically foretold by the fact that 23 percent of the population is 10 or under.

Despite the seriousness of the problem today and the increasing challenge in the years ahead, the central conclusion of the Commission is that a significant reduction in crime is possible if the following objectives are vigorously pursued:

First, society must seek to prevent crime before it happens by assuring all Americans a stake in the benefits and responsibilities of American life, by strengthening law enforcement, and by reducing criminal opportunities.

Second, society's aim of reducing crime would be better served if the system of criminal justice developed a far broader range of techniques with which to deal with individual offenders.

Third, the system of criminal justice must eliminate existing injustices if it is to achieve its ideals and win the respect and cooperation of all citizens.

Fourth, the system of criminal justice must attract more people and better people - police, prosecutors, judges, defense attorneys, probation and parole officers, and corrections officials with more knowledge, expertise, initiative, and integrity.

Fifth, there must be much more operational and basic research into the problems of crime and criminal administration, by those both within and without the system of criminal justice.

Sixth, the police, courts, and correctional agencies must be given substantially greater amounts of money if they are to improve their ability to control crime.

Seventh, individual citizens, civic and business organizations, religious institutions, and all levels of government must take responsibility for planning and implementing the changes that must be made in the criminal justice system if crime is to be reduced."

30. A fact not to be lost sight of is that many of the techniques and products of our technological age can be as readily adapted and directed to the promotion of criminal activities as to their detection. The police officer tends to become more and more a technician who must be provided with technical training and technical aids that will allow him to carry out his operational responsibilities competently and where necessary, gather and select with discrimination, evidence that must be passed to the laboratory for scientific opinions. As between the protection of the rights of the individual and the enforcement of law and order in this technological squeeze, modern society must find a means to have its cake and eat it. This Association is convinced that this is not an impossible task provided the problem is reviewed in its national perspective, and that intelligent planning and support is made available on the urgent basis it demands.

31. The DBS Police Administration Statistics[5], 1967 states that there were 42,541 persons employed in 1967 in the various police forces across Canada, an increase of 5.4 per cent over the 40,368 reported in 1966. The number of actual police officers totalled 35,881 for 1967 compared with 34,069 in 1966, a rise of 5.3 per cent.

32. It goes without saying that the most expensive commodity in any organization is the cost of manpower, and if these costs can be reduced by the application of

(5) DBS Police Administration Statistics, 1967

scientific and technological means every effort must be made to employ them.

33. Again to quote from the Report of the President's Commission "The Challenge of Crime in a Free Society[6] 1967, it is stated:

" The Scientific and Technological revolution that has so radically changed most of American society during the past few decades has had surprisingly little impact upon the criminal justice system. In an age when many executives in government and industry, faced with decisionmaking problems, ask the scientific and technical community for independent suggestions on possible alternatives and for objective analyses of possible consequences of their actions, the public officials responsible for establishing and administering the criminal law - the legislators, police, prosecutors, lawyers, judges, and corrections officials - have almost no communication with the scientific and technical community.

More than two hundred thousand scientists and engineers are helping to solve military problems, but only a handful are helping to control the crimes that injure or frighten millions of Americans each year. Even small businesses employ modern technological devices and systems, but the Nation's courts are almost as close to the quill pen era as they are to the age of electronic data processing. The police, with crime laboratories and radio networks, made early use of technology, but most police departments could have been equipped 30 or 40 years ago as well as they are today. Hospitals and clinics draw heavily upon the most recent developments in engineering and medical science, but the overwhelming majority of reformatories, jails and prisons are, technologically speaking, a century or more in the past.

This lack of contact between criminal justice and science and technology is true even in the Federal Government, where, as recently as 1965, the Justice Department was the only Cabinet department with no share of the roughly $15 billion Federal research and development budget."

34. The President's Commission, in collaboration with the Office of Law Enforcement Assistance, established a task force on science and technology in April, 1966. The task force was given the job of showing how the resources of science and technology might be used

(6) The Report of the President's Commission "The Challenge of Crime in a Free Society", Chapter 11, Science and Technology, p. 245

to solve the problems of crime. It found that within the criminal justice system, the greatest potential for immediate improvement by technological innovation appeared to be in police operations.

35. The Commission's report[7] states:

" Of all criminal justice agencies, the police traditionally have had the closest ties to science and technology, but they have called on scientific resources primarily to help in the solution of specific serious crimes, rather than for assistance in solving general problems of policing. The task force focused its efforts on some illustrative applications of science and technology to the broad problems of police operations.

The police control crime primarily by apprehending criminals and by posing a convincing threat of apprehension. The apprehension process begins either with the detection of a crime by patrol or by a report to the police, followed by the dispatch of police to the scene. Then come search, investigation, interrogation, data gathering, suspect checkouts and arrest, sometimes followed by more investigation and assistance in prosecution. The police field operations centering around apprehension are closely tied to technology. Automobiles, radios, crime laboratories, scientific investigation, and police weaponry are essential technical aids to the operations of a modern police force.

Science and technology can improve the capabilities of the police in the apprehension process."

36. The recommendations of the Commission on the application of science and technology to the criminal justice agencies commencing at p. 248[8].

37. The proceedings of the First Interamerican Conference on Legal Medicine and Forensic Science were published in 1964 with editorial comments by Professor Larry Alan Bear of the School of Law, University of Puerto Rico[9]. These proceedings are notable in the present context for both their international and Canadian content. In these proceedings, reference was made to an interesting statistic that was derived from two hundred responses to question-

(7) Ibid p. 247
(8) Ibid p. 248
(9) Law, Medicine, Science and Justice.
Larry Alan Bear, Conference Director and Brian Parker, Assoc. Editor, Charles C. Thomas Pub. Springfield, Illinois, U.S.A. 1964.

aires solicited in ten countries, relating to scientific crime detection services at national and local levels. In his comments, Professor Bear reveals[10] that it had been shown that under the most effective operating conditions in any country, 98% of all criminal cases were never subjected to any scientific examination.

38. The late Dr. H. Ward Smith, Attorney General's Laboratory, Toronto, Canada, speaking[11] to the same conference on "Forensic science in Canada", presented the analysis of Ontario Criminal cases here reproduced as Table II. The sordid facts are simply that out of 167,238 cases of crime detected in 1960, 67,731 were concluded and only 7,241, or 4.3% of the total, made recourse to laboratory assistance.

TABLE II

ANALYSIS OF ONTARIO CRIMINAL CASES 1956-60

	1956 Cases				1960 Cases			
	Known	Concluded	Lab.	% of Known	Known	Concluded	Lab.	% of Known
Murder Attempt murder Manslaughter	42	40	36	86	53	35	48	90
Crim. Negligence	22	22			115	97		
Common Assault	2,344	1,873			3,103	2,134		
Total	2,366	1,895	19	0.8	3,218	2,231	64	2
Indecent Assault Rape Attempt rape	640	482	88	14	1,266	724	144	11
Robbery, Break & Enter-Theft	54,950	13,513	66	.12	101,279	20,602	242	.24
Forgery, Fraud	Not listed		4		8,836	3,718	308	3.4
Miscellaneous Criminal Code Traffic	8,380	7,773	1,207*	14*	15,463	14,724	6,296*	41*
Other	28,450	20,403	82	0.3	37,123	25,697	139	0.5
Total	94,828	44,106	1,502	1.6	167,238	67,731	7,241	4.3

* Breathalyzer Cases - 1956-300 1960-5,182

(10) Ibid p. 428

(11) Ibid p. 458

39. It is generally agreed by forensic scientists that in crimes involving bodily contact, such as attempted murder, manslaughter, criminal negligence and common assault, there is an opportunity for the exchange of types of physical evidence (or "signatures") that is subject to detection by modern scientific methods.

40. Wilson and Roberts[12] speaking on the natural signature of chemicals and chemical dispersion systems, supply the following description of the trail left by an automobile:

> " A moving automobile is already a form of chemical disperser. Each mile it leaves a trail of approximately 700 g of gasoline combustion products, including more than 0.1 g of lead; 2 g of respiration products from each passenger; 1 g of lubricating oil products; 0.4 g of tires; and variable but typically lesser amounts of metal particulates, lubricant drippings, paint flecks, upholstery fibers, abraded brake lining, anti-freeze volatiles, electrical insulation degradation products, etc. While each car undoubtedly has a fully individual chemical signature, the identification problem is simplified if a known chemical marker can be caused to be left by the vehicle. When there is a brief period of access to the car of interest, the tracer can be added to existing components or simple attachments can be made".

41. There exists at the present time a scientific capacity or developable potential to detect these minor traces of matter. High flux neutron activation analysis is a tremendously powerful forensic tool with a capability for detecting traces of elements of the periodic system that may comprise less than one part per million in a sample substance. However, the material must be irradiated in a reactor or neutron accelerator. X-ray fluorescence offers a lesser degree of sensitivity and while limited to near surface analysis, is portable and potentially of great value to in-field investigators.

(12) E. Milton Wilson and R.M. Roberts.
Chemical techniques for marking and tracking.
Page 364, Vol. 1, Proceedings of the First National Symposium on Law Enforcement Science and Technology, Thompson Book Company, Academic Press, 1967.

42. Despite the existence of these aids, or their developability, the late Dr. Ward Smith's analysis (Table 11 above) indicates that only a minor percentage of crimes involving physical contact and detectable trails are given scientific or laboratory attention, and greater than half remain unsolved.

43. Having referred in their lecture to biological experiments dealing with the incredibly sensitive olfactory processes of certain insects and animals, Wilson and Roberts (loc. cit. page 363) continue with the following classic summing up of the technical aspects of our present situation:

> "In terms of man-equivalent body lengths, we live in a world where tracking occurs routinely up to 3000 miles and perhaps as far as 7000 miles. Yet how often is a human suspect under surveillance lost within one moderately crowded city block? How often does the law enforcement community have the knowledge of the path of a vehicle for a relatively short distance from a known starting point, such as a ransom drop site? How long must man rely on a "dumb" animal to relocate an escaped prisoner? Potential answers to these problems exist within present scientific knowledge, a selected few of which are explored further herein."

44. It would appear that this bottle-neck in the solution of criminal activities could be ameliorated and largely eliminated with an appropriate program of research and development.

45. But that is only one of many areas in which we are failing to apply or capitalize on existing levels of scientific and technological developments. The testing and evaluation of new aids and equipment and the analysis of their efficacy should be carried out with the utmost attention to proven scientific methods. The use of chemical mace in the United States has pointed up a typical example of shortcomings in observational control. It is reported[13]

(13) Joseph F. Coates. Safe Police Weapons, p. 59, Science and Technology, May 1968.
(Originally an industrial chemist Mr. Coates served as consultant to the President's Commission on Law Enforcement Science and Technology and is a senior staff member in the Scientific & Technical Division of the U.S.A. Institute for Defense Analyses).

that some 3000 police forces in the United States now employ mace and that it had, through November 1967, been used in approximately 1400 instances.

> "In spite of all this, (ibidem page 59) it is nearly impossible to find organized data on the consequence of the use of the weapon, its risks, opportunities, the changes it has wrought in police action. Aside from the release of selected anecdotes, either celebrating or disparaging its employment, data are almost unavailable."

46. This example clearly demonstrates what can happen when the scientifically established procedural cycle for the research, development, test, and evaluation of technical products is by-passed. It is imperative that technical preparedness be established and maintained for systematic and uniform evaluation methods as well as for technical, medical and tactical standards for the introduction of new devices and techniques. This kind of thing cannot be implemented piecemeal by police groups, but must be catalyzed at the national level.

47. It is not sufficient to see that the police agencies are properly equipped and trained, but steps should be taken to ensure that competent technical police work is not finally cast aside in the face of less competent adversary opinion in our courts. This can happen under Canadian rules of evidence where the prosecution and defence counsels may challenge each other's technical evidence on the basis of witnesses whose competence may be judged by a non-technical person on the basis of a very superficial exposition of credentials. It is not conceded by forensic scientists that the correct answer can be the

average of a competent and an incompetent opinion. The Honourable Chief Justice McRuer (loc. cit.) has neglected to offer guidance on this tricky problem even though he discourses to a considerable extent on the form and discipline of self-governing professions and societies who may be deeply involved.

48. Dr. Constantine J. Maletskos[14], speaking before a group of specialists in forensic analysis on the problems and pitfalls associated with the introduction and use of new scientific methods in court, recently proposed a committee system for the approval and accreditation of a scientific method before it is introduced into court. Going even beyond the national character that an approving body would have to reflect, Dr. Maletskos recognizes also a desirable international complexion.

> "To be effective", he proposed, "the certification would consider all aspects of the scientific method, and particularly, would take cognizance of the ultimate uses of the method. Thus, items to be considered in the certification would include an evaluation of the basic principles and concepts of the method, the capabilities of equipment and procedures, the assessment and control of difficulties, and the delineation of pitfalls, and, most importantly, the applicability to appropriate legal end-points."
>
> "In its general sense, the approving body would be a national body, perhaps even an international body, composed not only of scientists but also of persons associated with law and law enforcement. Irrespective of how the appropriate persons become members of the body, this body would be impartial and have complete independence, with no ties to any specific organization, administratively or financially. The body would have full authority for its decisions, the courts having given their sanction for its existence."

(14) Dr. Constantine J. Maletskos. On the Introduction of New Scientific Methods in Court. First International Conference on Forensic Activation Analysis, San Diego, California. (Dr. Maletskos is associated with the Department of Legal Medicine, Harvard University, and with the Cancer Research Institute, New England Deaconess Hospital).

49. In proposing a national body to examine technical police problems and the employment of technical aids for the pursuit of criminal justice, the Canadian Association of Chiefs of Police is therefore not proposing anything new or ultra radical, but things which our scientific and legal colleagues already recognize to fall within the course of rational progress.

50. By the Law Enforcement Assistance Act of 1965, (Appendix II) the United States took a first giant stride in the direction of modernizing its attitudes and approaches to modern crime and social unrest. Up to this point there had been no federal commitment to assistance in local law enforcement and crime control problems. The Act has operated[15] to stimulate activity and improvements in segments of the criminal justice process: police, courts, corrections, prevention research, study, planning, citizen action, organizational improvement, scientific and technological development.

51. The programme which is outlined in some detail in Appendix II has consisted of three essential parts:

(a) A comprehensive survey of potential application of science and technology to the agencies, methods, and problems of crime control.

(b) Two national symposia bringing the scientific and law enforcement communities in dialogue on first, general problem definition; second, exploratory excursion into specific problem areas.

(c) Research and development projects divided among: general information system design development; application of computer, operations research and ADP technology to specific operational and management problems; development of laboratory techniques and capabilities.

(15) Daniel I. Skoler, Office of Law Enforcement Assistance, United States Department of Justice, Washington. Paper entitled "Federal Assistance in Developing the Technology of Criminal Justice". First International Symposium on Law Enforcement Science and Technology loc. cit.

52. Also in 1965, the United Kingdom endeavoured to effect a similar reorganization and stimulation of its machinery for criminal justice by introducing the Home Office Scientific Council (Appendix III).

53. An immediate product of the United States' programme was a survey of crime laboratories and a report[16] on studies to develop curricula for forensic science training. The survey showed the existence of approximately 110 non-federal laboratories in the United States, and these were sampled to determine the personnel and equipment needs of additional laboratories that would be required to put laboratory services within reach of virtually all law enforcement agencies in the United States. Noteworthy of the conclusions reached are those concerning what the Board considered would constitute a model regional crime laboratory as follows:

> "A model regional crime laboratory as determined by the Advisory Board for this project would serve 500,000 to 1,000,000 people in an area where there are 5,000 Part I offenses per year. In accordance with the Crime Commission Report, all Part I crimes should be processed by a laboratory. Such a laboratory would have to be within two hours driving time of any point in its jurisdiction, and in sparsely settled areas, within two hours flying time from any point in its jurisdiction. The laboratory would offer complete technical services and analyses in the following fields: (1) Physiological fluids . ... (2) Hairs and fibers and other trace evidence . ... (3) Comparative microscopy. ... (4) Wet chemistry. ... (5) Instrumental analysis. ... (6) Document examination, writings, typewriting. ... (7) Polygraph. ... (8) Photography. ... (9) Latent prints. ... (10) Crime scene services. The Board of Consultants decided that the number of scientific personnel required to operate a regional laboratory which would provide the laboratory functions just enumerated is 12 to 20 scientific personnel. Such a laboratory

(16) Dr. Alexander Joseph. O.L.E.A. Project No. 013 Report: Study of Needs and the Development of Curricula in the Field of Forensic Science.
(Dr. Joseph is associated with the John Jay College of Criminal Justice, University of New York).

would require a capital budget of approximately $200,000. This amount of money would provide for a library, furniture and fixtures, comparison microscopes, a polarizing microscope, stereo microscopes, x-ray diffraction unit, emission spectrometer, infrared spectrophotometer, electrophoresis equipment, ultra-violet spectrophotometer, an analytical gas chromatograph, mobile units including trucks, equipment and supplies and miscellaneous photographic equipment."

54. If we accept the same laboratory dispersal factor for Canada, with an area of 3.9 million square miles, the Joseph formula suggests that Canada could use 144 laboratories. We do not suggest that such a number at $200,000.00 per installation is really needed here yet, but the actual requirement should be investigated because a serious requirement does exist.

55. A further observation of the report is that, given the necessary staff, training facilities, and graduated technical and scientific people, there is the important factor of keeping their knowledge up to date. The single most valuable method for doing this is attendance at professional meetings such as the Academy of Forensic Science, the Symposia on Science and Technology supported by the Office of Law Enforcement Science and Technology, and others. This fact has been recognized in Canada for some time, and we have endeavoured to encourage and assist our people to attend such meetings. One cannot overemphasize the value of professional contacts made at such conferences and their value to international cooperation. It is our earnest hope to achieve a suitable type of Canadian symposium on law enforcement science and technology and in this enterprise, as already stated, we have asked and are receiving the advice and assistance of the National Research Council. It is important that funds be forthcoming both to assist the

organization of such conferences and the attendance of law enforcement people from the length and breadth of the country.

56. A final point made by the Joseph report concerns sources of assistance that are ferreted out by law enforcement officers in scientific and academic institutions. Usually such assistance is based on professional personalities as, for example, university professors and specialist workers. While law enforcement officers are pleased to have this assistance and benefit by it, the loss of these contacts causes a loss of continuity in the assistance, and sometimes even a loss of capabilities. Hence what is needed is support for well founded departments such as the criminology departments at the University of Montreal, University of Ottawa, University of Toronto, and permanent government departments such as the National Research Council.

57. The electronic computer is both the heart and the handmaiden of modern information and communications media, and the capabilities which it makes available to law enforcement, already being exploited in many quarters, hold a wealth of as yet untapped and unexplored possibilities. We could not here hope to reveal more than a glimpse of the sophisticated workings of this tremendous area of aid which by its very nature must be considered in a completely national context. By this we do not mean to isolate the local police units from it, but rather to integrate the national police community in its entirety, right down to the law officer on the beat. Modern information

networks are able to assimilate, store, correlate and retrieve literally millions of pieces of information whose relationship and use would otherwise be limited or lost in our conventional forms of data handling which use the human coordinator. Thus it would be possible to put a critical piece of information originating at Vancouver through to a "walkie-talkie" on the outskirts of Montreal and back before a suspicious action has time to mature.

58. Superintendent O.W. Wilson, former head of the Chicago Police Department[17] has made a very strong appeal to put police officers where crimes are most likely to occur with the equipment, techniques and services that are most likely to prevent crime or apprehend the criminal at the scene. In this, every law officer would concur. Suitable equipment in crime prevention is usually equipment that gives information and in this sense, a small fact stored away in a national computer-controlled pool, can place vital information in the ear of a recipient within a properly organized communications net. Superintendent Wilson (ibid) casts us an interesting statistic on the value of rapid communication:

> "A study made 29 years ago indicated that if the police could respond to an emergency call within 30 seconds there was a 76 percent chance that they would apprehend the criminal. If they delayed longer than 90 seconds the chance of apprehending the offender at the scene fell to 26 percent. A recent study by the President's Crime Commission produced similar results."

(17) O.W. Wilson, Crime Prevention - Whose Responsibility? First National Symposium on Law Enforcement Science and Technology (loc. cit.)

59. What holds true for the presence of a police officer holds equally true for the presence of information in the right place at the right time. Taking into account the kind of information police use, such as criminal records, vehicle license identification, trial records and laboratory data, and bearing in mind that criminals move widely and quickly, or may be guided by distant colleagues, the need for centralized information storage with ready access from remote points, modern communication and information handling methods are a must in police organization. It is therefore urged that a study of this area of law enforcement aid should be carried out on a national basis.

60. In concluding, the Association would like to make a brief reference to the area of new problems that are generated by political events and social trends. In many instances, policies must first be formulated before acceptable technical means to carry them out can be determined. Invasion of privacy is raised as an objection to attempts by police at search or surveillance, sometimes on the grounds of principle and sometimes on the grounds of technical practice. The latter type of objection is subject to avoidance by research and development of technical equipment that does not embarrass or affront the individual.

61. The Criminal Code authorizes a police officer to search the person for offensive weapons, but only where he believes on reasonable grounds that an offence is being committed or has been committed with respect to it. Bearing this and the question of invasion of privacy in mind, airlines and the general public are clamouring for surveillance and the disarming of passengers who may carry

weapons and explosives on board aircraft. This implies the need for an effective though socially acceptable device of a sort that might also be used in other instances where an unidentified individual carrying a concealed weapon may be mingling in a crowd or negotiating a public area.

62. There is a good deal of sympathy in some quarters with the idea of compelling the public to use anti-crime devices in circumstances where there is a strong element of temptation or attraction to public mischief and crime. Again there is the question of constitutional rights. How far is the jump from requiring car owners to remove the ignition keys from their parked cars to requiring burglar alarms and other devices in their homes? Is there an economic technical answer that will permit citizens to be protected where they wish it?

63. In recent times there has been a growth in medical and psychological aids to interrogation, some of which are legally unacceptable, some of which are technically unsound, and others which hold promise but require development and evaluation. "Truth" drugs, alcoholic intake analysers, galvanic response meters, etc. are typical instruments of aid to police investigators, but require a tremendous amount of scientific study and analysis to render their operation certain and accurate for use in the pursuit of criminal justice. It is important that staff, facilities, and funds be made available for furthering progress in this area.

64. To summarize the important points which we would like to leave with the Senate Special Committee for consideration, crime is big business and has at its command the same technology that is or should be available to

police agencies. In many instances organized crime is ahead and better equipped for its function than the majority of local or regional police agencies. When one considers the whole gamut of criminal activities, including theft, conversion, business manipulations, property destruction, gambling and other forms of racketeering, etc., which together provide dependable incomes and security for an embarrassingly large section of society, one is faced with an astronomical bill for the law abiding taxpayers. Attempts to put an exact figure to this loss has resulted in estimates from 5 to 50 billion dollars[18] per annum in the United States and this wave of crime more than washes at the border of Canada.

65. The problems confronting law enforcement agencies are therefore supra-regional and must be studied and attacked on a national and even international scale. There are so many facets to the problem - political, juridical, socialogical and technological - that what is required at the present time is a nationally constituted committee of disciplinary experts in science, law, medicine, etc. to study the state of national organization and preparedness, priorities, and scientific support policies. The work of the police forces must be assisted by adequate forensic laboratories, and with permanent facilities to carry out research and development on scientific and technological aids. The police must be given nation-wide communications and information systems, and facilities for modern technical training

(18) Peter D. Andreoli, Assistant District Attorney, New York County, New York, speaking on "Organized crime enterprises - legal". First National Symposium on Law Enforcement Science and Technology (loc.cit.)

to handle the job they are expected to carry out. More critical and constructive attention must be given to devising acceptable means to combat the problems posed by political events and social evolutionary trends; people qualified to deal with the analysis of these problems and who can promote the scientific and technical support needed by police agencies should be made available in the universities and appropriate government departments.

D. RECOMMENDATIONS

66. It is therefore specifically recommended that an appropriately constituted Canadian council of law enforcement science and technology be constituted as a matter of national urgency, and charged with tasks to include at least the following:

(a) To carry out a review in depth of the organizational preparedness of the total Canadian law enforcement community to meet current and future needs in the art and science of law enforcement.

(b) To review Canadian Departmental responsibilities, capabilities, and activities in the evaluation of requirements in law enforcement science and technology, with particular reference to the innovation and support of research and development work, the feedback and evaluation of requirements from the operational level; channels of national coordination; funding and long range planning of research and development requirements.

(c) To establish a special study group to examine current and future needs for the acquisition, sorting, storage, analysis, retrieval and distribution of law enforcement information with

particular reference to the need for a national computerized communication and information net, together with a priority rating in relation to competing demands for satellite communications space.

(d) To consider the need for interdisciplinary studies of forensic science with particular reference to the development and evaluation of new scientific tools and techniques, and their introduction into courts of law.

(e) To review the adequacy of police training facilities in present day technological perspectives, and to consider a national policy for the provision, support, maintenance and utilization of regional training centre facilities.

(f) To review the problems of law enforcement in relation to social and political evolutionary trends with reference to civil rights, organized crime, civil unrest, questions of surveillance, and developing areas such as psychological aids to interrogation.

(g) To review the need for the development of international co-operation and participation in law enforcement science and technology.

(h) To consider means for obtaining the support of academic and scientific institutions, such as the criminology departments of the University of Toronto, University of Montreal and University of Ottawa, and permanent government departments such as the National Research Council.

(i) And among other things to study means of developing:

a. through the use of computers and other sophisticated equipment, rapid methods of searching and identification of fingerprints, particularly latent fingerprints;

b. improved methods of radio communication, for example, personal radios for police officers, and miniature or pocket-type recorders for field interviews;

c. improved surveillance equipment;

d. equipment which will automatically pinpoint the location of police vehicles;

e. improved alarm and intrusion detection devices for the purpose of preventing crime;

f. non-lethal aids for the use of the police to quell mob disorders without effecting injury to the participants.

* * * * * * * * * * * * * * *

Dated at Ottawa, Ontario, Canada, this 1st day of March, A.D., 1969, and signed for and on behalf of the Canadian Association of Chiefs of Police by

D.N. Cassidy
D.N. Cassidy,
Secretary-Treasurer.

APPENDIX I

CANADIAN ASSOCIATION OF CHIEFS OF POLICE, INC.

1. Letters Patent, incorporating the Canadian Association of Chiefs of Police, under Part II of the Canada Corporations Act were issued on March 26, 1968, and recorded May 17, 1968. Film 220, Document 151, by the Deputy Registrar General of Canada.

2. Board of Directors.

Officers:

President	Chief C. Einfeld, East Kildonan, Man.
1st Vice-President	Chief A.G. Cookson Regina, Sask.
2nd Vice-President	Chief F.G. Carroll, London, Ont.
3rd Vice-President	Director J.P. Gilbert, Montreal, Que.
Immediate Past President	Lt.Col. E.A. Spearing, M.B.E., Director of Investigation, Canadian National Railways, Montreal, Que.
Secretary-Treasurer	Director D.N. Cassidy, Police and Security, National Harbours Board, Ottawa, Ont.

Directors:

Chief M.A. MacBrayne,
West Vancouver, B.C.

Commissioner Eric Silk, Q.C.
Ontario Provincial Police,
Toronto, Ont.

Deputy Commissioner W.H. Kelly,
Royal Canadian Mounted Police,
Ottawa, Ont.

Chief S.D.A. Wannamaker,
Summerside, P.E.I.

3. Standing Committees:

Auto Theft
Communications
Constitution
Credentials
Crime in Industry
Crime Prevention and Juvenile Delinquency
Decorations
Finance
Law Amendments
Nominations
Organized Crime
Resolutions
Selection and Training
Traffic
Uniform Crime Reporting

4. Steering Committee on Law Enforcement Science and Technology.

Chairman:	Lt.Col. E.A. Spearing, M.B.E. Immediate Past President, Canadian Association of Chiefs of Police, Director of Investigation, Canadian National Railways, Montreal, Que.
Secretary:	D.N. Cassidy, Secretary-Treasurer, Canadian Association of Chiefs of Police, Director of Police and Security, National Harbours Board, Ottawa, Ont.
Police Advisors:	Superintendent C.R. Eves, Ph.D., Director, National Police Services, Royal Canadian Mounted Police, Ottawa, Ont.
	Mr. Guy Tardif, Planning and Research, Police Department, Montreal, Que.
	Asst. Commr. A.H. Bird, Ontario Provincial Police, Toronto, Ont.
	Supt. J. Ackroyd, Metropolitan Police, Toronto, Ont.
	Inspector P.A. Easler, Crime Detection Laboratory, Police Department, Vancouver, B.C.
Consultants:	A.H. Hall, B.Sc., M.Sc.(Caltech), Head, Structures & Materials Laboratory National Aeronautical Establishment, National Research Council, Ottawa, Ont.
	E.A.G. Shaw, B.Sc., Ph.D.(London) Senior Research Officer, Division of Applied Physics, National Research Council, Ottawa, Ont.

5. Affiliations:

Closely associated with the following groups as many of our members belong to provincial, regional and international associations of police chiefs:

Maritime Association of Chiefs of Police
Quebec Police and Fire Chiefs Association
Ontario Association of Chiefs of Police
Western Chiefs of Police Conference
International Association of Chiefs of Police

APPENDIX II

LAW ENFORCEMENT ASSISTANCE ACT, UNITED STATES

1. The Law Enforcement Assistance Act (LEAA) has been in effect for three years. It was designed to foster new approaches, new capabilities and new resources for dealing with crime and criminals. Briefly, the Act authorizes the Attorney General of the United States to make grants to, or contract with, public or private non-profit agencies to improve training of personnel, advance the capabilities of law enforcement bodies and assist in the prevention and control of crime. The Act also authorizes the Attorney General to conduct studies, render technical assistance, evaluate the effectiveness of programs undertaken, and disseminate knowledge gained as a result of such projects. Police, courts, corrections and other mechanisms for the prevention and control of crime are all within its scope.

2. The Law Enforcement Assistance Act was conceived as part of a larger and comprehensive program to increase federal participation in the United States efforts to cope with rising crime.

3. The LEAA program is administered by the Attorney General through the Justice Department's Office of Law Enforcement Assistance. The staff of this office work with advisory panels constituted by the Attorney General to review specific projects and provide general program guidance and is the focal point for development of programs, processing of applications, monitoring projects, and day to day grant administration.

4. Appropriation in the amount of $7.249 million, $7.25 million and $7.5 million were approved by Congress for the three fiscal years (1966, 1967, and 1968) during which the Act has been operative. The first grant award

was made in December, 1965 and to April, 1968, 330 separate projects have received nearly $19 million in assistance awards.

5. On April 25, 1968 the Attorney General reported to the President and Congress of the United States:

"Pursuant to the provisions of Section 11, Public Law 89-197, I am pleased to submit this report on activities under the Law Enforcement Assistance Act of 1965.

The Department of Justice has, in 30 months, granted some $19 million for 330 criminal justice projects in 50 states, the District of Columbia, the Virgin Islands, Guam and Puerto Rico.

The Act has helped awaken America to the need for a national renaissance in law enforcement and criminal justice.

Comprehensive Law Enforcement Assistance (LEA) programs have motivated state and local governments toward significant actions, strengthening the fabric of our criminal justice system:

-- 27 grants have financed state crime evaluation and planning commissions. None existed before this program. Each provides a major opportunity to implement the recommendations of President Johnson's Crime Commission and to effect other important improvements. Each state has been urged for more than two years to form such a commission. Each state needs one.

-- 34 grants to police departments have financed police-community relations programs addressed directly to law enforcement's most pressing problem.

-- 27 grants have been awarded for police-science courses in colleges and universities, nearly doubling the number of states with schools offering such study. These courses provide a major opportunity for professionalization of police.

-- More than 650 police departments, with federal support, are using filmed and printed training materials carefully developed by experts under the supervision of the International Association of Chiefs of Police.

-- 21 states have received grants to develop comprehensive training programs for correctional officers in prison, probation and parole work. Only six states had such programs previously. These programs can have a profound long range impact on the recidivist who commits most controllable crime.

-- 20 states have received grants to develop or improve state police standards and training activities. These grants can begin statewide improvement of law enforcement.

-- 120 police departments have participated in riot prevention and control seminars sponsored by the International Association of Chiefs of Police and the Department of Justice.

This pioneer program of modest federal financial assistance has stimulated exciting innovations in the science of law enforcement, which when fully implemented will make a safer America.

The National Crime Information Center, financed through the LEA program, is the most advanced and needed crime data operation ever undertaken in the United States. Programmed to prevent invasion of privacy, it offers police throughout the nation instant fact on stolen property and wanted felons. Several hundred identifications are being made each week through this computerized service.

Significant research projects have been financed through the LEA program. These include a comprehensive study of the application of science and technology to criminal justice, a study on pooling police services, a survey of unreported crime which tells us much about the silent sufferance of crime and how to remedy it, and national surveys of police laboratory needs, correctional agency capabilities and police-community relations programs and problems.

These are but a few of the many projects supported by LEA. New scientific and technological advances have been developed and applied to criminal justice; new techniques have been devised, new experiences gained, new concepts tested, new knowledge passed on to all relevant agencies; proven programs have been expanded.

Unquestionably, LEA as small as it is, has provided significant stimulation toward implementation of the Crime Commission's recommendations. More than all else, it clearly demonstrates the great need for and the feasibility of the massive financing promised by the Safe Streets and Crime Control Act. LEA has pioneered the way. It is time now for the vast reforms so urgently needed."

6. 6 In the conclusion to his report it is stated:

"With federal, state and local criminal justice agencies spending more than $4.5 billion annually for crime control and the public cost of crime totaling far in excess of that amount, it is clear that LEAA, even with the most efficient utilization of its modest resources, could hope for but limited impact. Yet, on a scale perhaps unusual for a program of this size, major law enforcement and criminal justice agencies, universities, research organizations, and professional associations across the nation have undertaken important and needed work under the stimulus of LEAA aid. Many States and localities, moreover, have been assisted in advancing from "have not" to "have" status in important areas of criminal justice capability.

Since most projects remain to be completed, a definitive assessment of the LEAA effort is not possible. Unfortunately, OLEA's inability to secure the increasing level of appropriations envisioned by Congressional authorizations and Departmental requests has prevented the kind of growth which would have maximized the value and effect of its programs. Nonetheless, the contribution discerned at the writing of the Second Annual Report has, if anything, been confirmed by an additional year of program effort. Briefly stated:

-- The LEAA program has made possible a variety of projects to aid and advance law enforcement capabilities. In varying degree these will help set standards, provide models, produce knowledge and build structures needed for a more effective response to the crime problem.

-- The program has served as a preparation and laboratory for the expanded grant-in-aid partnership required for the war on crime. It has given the Department experience and perspectives in the methods and techniques of federal assistance, the problems and dilemmans of grant program administration, and the type of "client" it serves in dealing with state and local law enforcement.

-- LEAA has been a moving force, though not the only one, in a process that has been preparing law enforcement to examine its problems and more vigorously toward their resolution.

Experience continues to indicate the critical importance of a substantial expansion of the "research and development" effort assigned to LEAA. It has shown also the Act's inability to respond to existing needs which require national subsidy support for our crime-fighting institutions. Both of these problems have been recognized in plans for the future and are embodied in legislation now pending before the Congress -- the proposed Safe Streets and Crime Control Act of 1967. Under this legislation, the experimental work of LEAA would be continued, expanded, and combined with a companion program for grant-in-aid support reaching into all states and localities willing to join with the Federal Government in increasing local commitment to law enforcement and criminal justice improvement. President Johnson has requested $100 million as an initial appropriation for this program. Substantial and rapid growth beyond this is contemplated in the years ahead."

APPENDIX III

HOME OFFICE SCIENTIFIC COUNCIL

1. The Home Office Scientific Advisory Council was set up in 1965. Its terms of reference are to advise the Home Secretary on the scientific aspects of research for the police service including forensic science. The Advisory Council has two committees: a Forensic Science Committee and a Police Equipment Committee.

2. Members of the Scientific Advisory Council are drawn from academic and industrial fields and are representative of a wide range of scientific disciplines; they are, therefore, collectively equipped to take an embracing view of the problems of police research. As a council they consider the projects in hand and subject them to careful analysis, sometimes suggesting a fresh approach or an improvement of methodology; they do not undertake projects although, on occasions, individual members are able to furnish assistance out of the scientific resources at their command or which they are able to influence.

3. The Council meets on an average of four times a year but its two committees, i.e. Forensic Science Committee and Police Equipment Committee, meet more frequently to consider projects.

4. Members of the Council give their service without fee and are reimbursed for out of pocket expenses.

5. It is worthy to report the Recommendations contained in the First Report of the Home Office Scientific Advisory Council issued May 7, 1968:

RECOMMENDATIONS

"Having carried out a comprehensive survey of the areas of research within our terms of reference, we recommend, in regard to the forensic science service, that:

(i) increasing productivity of the forensic science service resulting from the application of improved methods cannot be expected to match the constantly rising case load and plans should be made urgently for commensurate increases of staff in future years.

(ii) the forensic science laboratory of the future should be planned and built with the long term needs of the service in mind; and we strongly support the re-building programme which has been started by the Home Office;

(iii) greater use should be made of modern methods of chemical analysis;

(iv) to avoid duplication of expensive equipment and skilled manpower plans should be made for specialized facilities, served by advanced methods of data handling and intercommunication, to be concentrated into a centralised service co-ordinated by the Home Office;

(v) because of the health hazard, we consider that the benzidine test should be replaced as soon as possible by alternatives which employ non-carcinogenic reagents;

(vi) the technique of neutron activation analysis and mass spectrometry for the examination of trace elements should be exploited urgently.

We also recommend, in regard to police equipment, that:

(vii) further consideration should be given to the application of the most advanced electronic techniques to problems of surveillance, intruder detection and communications;

(viii) as research into the location and identification of hidden objects is being carried out by Defence Departments, the review of available techniques should, if possible, include their work in this field;

(ix) the planned experiments in the use of simple scientific techniques in searching scenes of crime should be speedily completed;

(x) the Home Office programme of research into automatic finger print retrieval should continue to be flexible enough to allow the most promising lines to be readily followed.

FUTURE PROGRAMME

Your Council is to meet on a number of occasions during 1968. In addition to continuing its review of the topics mentioned in this report it is intended to consider the field of operational research since this has a strong bearing upon the aspects of police research upon which it is our duty to advise."

BIBLIOGRAPHY

1. DBS Crime Statistics, 1967.

2. DBS Crime Statistics, 1967.

3. DBS Traffic Enforcement Statistics, 1967.

4. President's Commission "The Challenge of Crime in a Free Society", p. v and vi of Summary, 1967.

5. DBS Police Administration Statistics, 1967.

6. President's Commission "The Challenge of Crime in a Free Society", Science and Technology, p. 245.

7. President's Commission "The Challenge of Crime in a Free Society, Science and Technology, p. 247.

8. President's Commission "The Challenge of Crime in a Free Society, Science and Technology, p. 248.

9. Law, Medicine, Science and Justice. Larry Bear, Conference Director and Brian Parker, Associate Editor, Charles C. Thomas, Pub. Springfield, Illinois, U.S.A. 1964.

10. Law, Medicine, Science and Justice, p. 428.

11. Law, Medicine, Science and Justice, p. 458.

12. E. Milton Wilson and R.M. Roberts, Chemical techniques for marking and tracing p. 364, Vol. 1., Proceeding of the First National Symposium on Law Enforcement Science and Technology, Thompson Book Company, Academic Press, 1967.

13. Joseph F. Coates, Safe Police Weapons, p. 59, Science and Technology, May, 1968.

14. Dr. Constantine J. Maletskos On Introduction of New Scientific Methods in Court. First International Conference on Forensic Activation Analysis, San Diego, California.

15. Daniel I. Skoler, Office of Law Enforcement Assistance, U.S. Department of Justice, Washington. Paper entitled "Federal Assistance in Developing the Technology of Criminal Justice." First International Symposium on Law Enforcement Science and Technology.

16. Dr. Alexander Joseph. O.L.E.A. Project No. 013 Report: Study of Needs and the Development of Curricula in the Field of Forensic Science.

17. O.W. Wilson. Crime Prevention - Whose Responsibility? First National Symposium on Law Enforcement Science and Technology.

18. Peter D. Andreoli, Assistant District Attorney, New York County, New York, speaking on "Organized crime enterprises - legal". First National Symposium on Law Enforcement Science and Technology.

APPENDIX 197

BRIEF TO THE SPECIAL COMMITTEE ON SCIENCE POLICY

THE SENATE, OTTAWA

MARCH 24, 1969

Brewers Association of Canada
66 Lisgar Street, Ottawa 4, Canada
Telephone Area Code 613-232-9601

21562—6½

PREFACE

1. This submission is presented on behalf of the Brewers Association of Canada which was incorporated by letters patent in 1943 under the provision of Part II of The Companies Act, 1934, and changed its name from the Dominion Brewers Association in July, 1963.

2. The Association voices the viewpoint of the brewing industry on such matters as government fiscal and legislative policy as it affects this industry; it also acts as a central gathering and distribution point for statistics and information concerning the industry; it performs such other functions as instituting industry research, and it supports and directs the Brewing and Malting Barley Research Institute in collaboration with the malting industry.

3. The brewing industry has from its inception recognized the importance and value of research and quality control. While a considerable effort has been extended over the years by member companies, this submission is confined to activities in the field of research carried out on behalf of member companies through the Brewers Association of Canada, together with general observations related to research in Canada and how it might be extended.

BREWING AND MALTING BARLEY RESEARCH INSTITUTE

4. The Brewing and Malting Barley Research Institute was established in 1948 by the brewing and malting industries of Canada and is financed by the Brewers Association of Canada on behalf of member companies, and the malting companies. The Institute was incorporated to provide a mechanism through which programs could be undertaken to assist in the improvement of malting barley, the basic raw material of the brewing and malting industries.

5. Since the Brewing and Malting Barley Research Institute was established, funds in the amount of 1.8 million dollars have been provided on the ratio of 75 per cent from the brewing industry and 25 per cent from the malting industry in Canada.

6. The primary objective of the Institute is to cooperate and assist, financially and otherwise, in the development and testing of improved barley varieties and to disseminate factual information on the production, improvement and processing of malting barley.

7. It is fully recognized that such cooperation and assistance will be of direct benefit to barley as a crop and that many of the improvements achieved will apply equally to malting barley and feed barley.

ORGANIZATION

8. Overall activities of the Institute are the responsibility of the Board of Directors which consists of senior representatives from the brewing and malting industries. Technical activities are under the direction of a Technical Committee composed of representatives from the brewing and malting industries, the Canada Department of Agriculture, the Grain Research Laboratory of the Board of Grain Commissioners for Canada, and the Master Brewers Association of America.

9. The Advisory Committee of the Institute meets annually to review various aspects of the Institute's program. This committee includes representatives from the brewing and malting industries, Canada Department of Agriculture, Grain Research Laboratory of the Board of Grain Commissioners for Canada, and five universities. The representatives on the Advisory Committee are highly qualified individuals active in the areas of barley breeding, soil science, cereal chemistry, agricultural economics, agricultural extension, animal nutrition, research administration and commercial barley production.

FACILITIES AND STAFF

10. The Institute maintains offices, laboratories, and a pilot brewing plant in Winnipeg. The staff consists of a Managing Director with B.S.A. and M.S. degrees in agronomy, a Chemist with a B.Sc. degree. three experienced technicians taking advanced training, and a secretary.

ACTIVITIES

11. The Institute is active in three major areas:

i) financial support of barley research at universities;

ii) evaluation of the brewing quality of new barley varieties and selections produced in research programs across Canada;

iii) liaison and extension work:

SUPPORT OF BARLEY RESEARCH

12. Grants in support of barley research have been made by the brewing and malting industries for over 40 years. Since the formation of the Institute in 1948, research grants made directly to universities have exceeded $440,000.

Support of Barley Research (continued)

	Total Industry Grants 1948 - 1968
University of British Columbia, British Columbia	$ 29,000
University of Alberta, Alberta	61,500
University of Saskatchewan, Saskatchewan	106,505
University of Manitoba, Manitoba	92,200
University of Guelph, Ontario	78,900
Macdonald College, Quebec	74,300
	$ 442,405

Annual grants in the amount of $35,200 were approved for 1968. This represents an increase of 50 per cent over the $23,400 provided in 1966, in accordance with recommendations made by the Advisory Committee of the Institute.

Grants are made in overall support of barley research programs being conducted by universities and specific projects are not assigned by the sponsors.

Financial support from the industry has been used primarily in the area of "applied" rather than "basic" research with the objective of accelerating the practical use of fundamental knowledge already available.

13. The research funds provided have been used in Canada for three major purposes:

i) to establish graduate assistantships at the Masters or Ph. D. level;

ii) to equip and staff quality testing laboratories at three universities;

iii) to provide general support for barley research programs.

QUALITY EVALUATION

14. The pilot brewing plant and laboratories of the Institute are operated for the purpose of evaluating the brewing quality of new barley varieties and selections in collaboration with the Canada Department of Agriculture, the National Research Council, and universities.

Quality Evaluation (continued)

The Institute cooperates closely with the Grain Research Laboratory of the Board of Grain Commissioners for Canada and conducts brewing trials in connection with basic quality investigations being carried out by the Grain Research Laboratory.

LIAISON AND EXTENSION

15. Close liaison between industry, research personnel, and others directly concerned with barley research, production, marketing and processing is maintained through scheduled meetings sponsored by the Institute and by personal contact.

RESULTS - IMPROVED VARIETIES

16. Financial support and quality evaluation tests provided by the Institute have materially assisted in the development of improved barley varieties. The improvements attained in recently licensed varieties have been significant for both agronomic performance and quality characteristics. The degree of improvement for one agronomic character, yield per acre, and one quality factor, per cent malt extract, is illustrated below:

BARLEY VARIETY IMPROVEMENT
(Regional and Cooperative Barley Test Data)

Year Licensed	Variety	Yield per acre (Bushels) 4-year average, 1963-66	Malt Extract (per cent)
1910	O.A.C. 21 (malting)	49.0	73.0
1956	Parkland (malting)	55.6	74.3
1961	Keystone (feed)	58.1	-
1965	Conquest (malting)	57.9	74.6
1966	Galt (feed)	61.5	-
1968	Paragon (malting)	60.6	75.6

Results - Improved Varieties (continued)

The major improvements achieved in recently developed new varieties have been in agronomic characteristics - yield per acre, disease resistance, improved standability - factors which are of utmost importance to the barley grower whether he is producing barley for malting and brewing or for livestock feeding purposes.

17. The significance of these improvements to the barley producer is clearly illustrated by the rapid increase in popularity of the new variety, Conquest, licensed in 1965, and the concurrent increase in total barley acreage.

	Total Barley Acreage in the Prairie Provinces (1,000 acres)	Per cent of Acreage Occupied by Conquest
1964	5,217	0
1965	5,741	1
1966	7,010	11
1967	7,600	31
1968	8,330	38

The favourable agronomic performance and good quality characteristics of Conquest have provided a dual-purpose variety for many producing areas in Western Canada, both of suitable quality for maltster and brewer and high yield per acre for the livestock feeder.

TRAINING OF SCIENTISTS

18. Research grants from the Institute have made a major contribution to the training of agricultural scientists in Canada by providing graduate assistantships and fellowships.

Many persons now in responsible positions in active research work and administration received support for their professional training from industry grants to universities.

LIAISON

19. The Institute has provided a means whereby close liaison can be maintained between professional personnel working in all phases of barley research, technical and administrative personnel in the brewing and malting industries, government extension agents and the grain trade.

20. Effective communication of factual information is a fundamental requirement if progress is to be made in any area. For barley in general, and malting barley in particular, the Institute provides a mechanism for exchange of information and discussion of progress, problems, and future plans.

21. In the overall quality testing program there is full cooperation between the Canada Department of Agriculture, the Grain Research Laboratory of the Board of Grain Commissioners for Canada, universities and industry. Results of tests are freely exchanged and an overlapping of membership on Institute and other committees ensures complete coordination of efforts.

22. Barley quality requirements of the brewing and malting industries have been defined and discussed with research workers. While only a very limited amount of reliable data is available on the feeding quality of individual barley varieties, a general appraisal of present information suggests that quality objectives for these two uses of barley may have much in common.

EXTENSION

23. Extension activities of the Institute, have been effective in transmitting research, production and market information to producers through publications and open farm meetings of an educational nature.

SUMMARY

24. The brewing and malting industries, through the Brewing and Malting Barley Research Institute, have provided, and continue to provide, a significant amount of support for barley research in Canada. Contributions in the form of research grants and support of facilities and personnel for quality testing can be readily defined.

25. The value of these contributions is evident in the number of superior barley varieties developed and their adoption by farmers. Improvements achieved have been of direct benefit to the grower, the brewer, the maltster, and the livestock producer.

26. Improved malting varieties for export both as barley and malt also offer increased advantages for the producers.

27. Also of great significance, but more difficult to define, are the contributions made to the training of scientific personnel in Canada, and the benefits derived from the catalytic effect on research which results from cooperative work and mutual understanding of problems, procedures and goals.

GENERAL OBSERVATIONS

28. Based on its long established interest and involvement in research, the brewing industry in Canada believes the Special Committee on Science Policy will serve to generate in Canada a greater national knowledge of the functions of research which it considers essential to the orderly and more rapid development of our economy.

The industry recognizes that research involves more than engaging a staff of trained personnel, providing laboratories and hoping for favourable results, and that the constant services and direction of management are also required to avoid excessive costs.

General Observations (continued)

The ever increasing demand for innovation, new ideas, new products, and increased productivity, is recognized. It is also recognized that research is one of the best weapons we have in our trade arsenal both domestic and foreign, because through research we can constantly improve and develop products which the consumer needs and will purchase with little regard as to whether it is produced domestically or imported.

29. Government assistance through taxation inducements - subsidies and other areas - has contributed to the development of research in Canada, pragmatic and all as the overall program may appear to be today. Recognition by the government that greater emphasis should be placed on accelerating industrial research and development and that a greater proportion of future financial resources should be directed towards development, where a more immediate return can be expected, is welcomed by the industry.

RECOMMENDATIONS

30. To provide better coordination for research in Canada it is respectfully submitted that consideration be given by the Special Committee on Science Policy to the following recommendations:

1. That there be established a Canadian Scientific Advisory Council composed of representatives of departments of the Federal Government engaged in research, representatives of industry, universities, research institutes and learned societies, to study and make recommendations to government.

Recommendations (continued)

2. That there be a review of present financial inducements for research with a view to extending this form of assistance for research and development designed to keep Canada abreast of technological developments in the world and maintain and advance our competitive position.
3. That there be developed a method for an interchange of scientists employed on research by government and industry with interchangeable use of their respective laboratories and facilities.
4. That the duties of Canada's highly qualified and experienced Foreign Trade Service be expanded to include extensive reporting of foreign successes in the fields of science, technological progress, new products and methods, and that there be facilities established within the Department of Industry, Trade and Commerce to disseminate information acquired to Canadian industry.

Respectfully submitted on behalf of the Brewers Association of Canada.

N.E. Hardy
Chairman - Governing Committee
Brewers Association of Canada

March 24, 1969

APPENDIX 198

BRIEF PRESENTED BY

VOICE OF WOMEN
LA VOIX DES FEMMES

TO

THE SENATE OF CANADA
SPECIAL COMMITTEE ON SCIENCE POLICY

SPRING 1969

VOICE OF WOMEN
LA VOIX DES FEMMES

VOICE OF WOMEN - LA VOIX DES FEMMES 577 JARVIS STREET TORONTO ONTARIO

INTRODUCTION

Voice of Women/La Voix des Femmes considers the deliberations of this Committee to be of extreme importance. We hope that out of its discussions a Canadian science policy will emerge that reflects the true values and priorities of Canadians in 1969. Having studied the previous submissions to the Committee, we will endeavour to avoid repetition of points already made. We will speak from the point of view of the citizen who provides the taxes to finance most of the research conducted in Canada, and whose life and future may be fundamentally affected by the manner in which the Federal Government directs the support of scientific research and development.

We believe that the increased knowledge and insight which result from an intelligent pursuit of science can and must be utilized to improve the quality of life for all. We believe that the Federal Government can make meaningful choices in the allocation of resources and can accelerate or retard the social benefits of increased knowledge.

In a 1964 paper on "Science and Parliament", Nigel Calder discussed ways in which different social priorities can be expressed in a different emphasis on technical developments. Table I is a summary of parts of his analysis.

TABLE I

Conceivable differences of technical emphasis under different policies for an advanced country.*

FAVOURING COMPETITIVE PRIVATE ENTERPRISE	FAVOURING NATIONAL OR MONOPOLY PLANNING
Versatile programmed production methods	Large automated transfer production lines
Small technical projects	Large technical projects
Small computers	Large computers
Small power units	Large power units
Better telecommunications and transport	More elaborate weapons systems

FAVOURING RESPECT FOR THE INDIVIDUAL	FAVOURING SOCIAL WELFARE
Greater variety of products	Preventive medicine
Psychological research	Social sciences
Ergonomics	Building and urban research
Consumer research	Rural projects

FAVOURING OWN NATION	FAVOURING WORLD DEVELOPMENTS
Newer technologies	Older technologies
Synthetic products	Natural products
More profitable food production	Greater food production
Weapons	Reproductive physiology
National space programme	Tropical medicine
	Earth sciences

*Nigel Calder: "Science and Parliament"
New Scientist - 28th May 1964, p. 535

Clearly a science policy is a social policy; it can only properly be formulated in relation to social goals. Therefore it should be formulated on the basis of discussions involving concerned non-scientists who have some grasp of the social implications of science and not by scientists alone. And it should be so formulated, not once and for all but continuously.

In the past, unfortunately, there has been little opportunity for a public discussion of Canadian science policy especially discussions of the problems related to the use of science and technology as instruments of Government policy. It seems extraordinary that in an industrialised society such as Canada, where fiscal policy has long been recognised as an effective tool of Government and is constantly debated and scrutinised, science policy, although an equally important instrument of power, is formulated solely by scientists and civil servants.

Parliamentary discussion on science and technology tend to be concerned with techniques and costs and rarely questions the basic purposes towards which techniques are applied. However, it is the discussion of the goals of any technical endeavour that must precede the detailed evaluation of methods and costs.

It is commonplace to acknowledge that science and technology have fundamentally changed the nature of our society; but paradoxically, the changed goals of this society have not entered at all into the current discussions of Canadian science policy. Dramatic evidence of this observation can be found in the Report No. 4 of the Science Council of Canada "Towards a National Science Policy for Canada". This report contains a chapter on national goals as a framework of science policy and on the contributions of science and technology towards achieving these goals. (The appropriate sections of the report are quoted in Appendix I A.)

We take strong exception to these goals as the framework of a Canadian Science policy - they are not our goals or those of many other Canadians. As formulated in the report of the Science Council, these goals represent precisely the aims of a society which has alienated a large group of its young people and failed to provide meaningful challenges to their intelligence and enthusiasm. In Appendix IB a prize winning essay "The World We Hope For", written by a 16-year old student from Uruguay and published in "UNESCO COURIER" is reprinted to illustrate the vast contrast between these goals and those of the Science Council. The young people of Canada, whose life and work will after all be most affected by any future Science policy, have far more empathy with the "World We Hope For" than with the uses to which the Science Council wishes to put Canada's technical knowledge. We can only urge the Committee to contemplate this evidence earnestly and not to let the technicalities of scientific discussions unduly dominate its deliberations.

During the past seven years Voice of Women/La Voix des Femmes has informed its members and the general public on such matters as radio-active fallout, nuclear weapons, the implications of sophisticated modern weapons systems such as ICBM's and anti-missile missiles as well as on environmental pollution. Our experience has convinced us that the Canadian public is perfectly capable of understanding technical matters. It is a myth to believe that laymen cannot comprehend the implications of science. If properly presented the citizen can understand the consequences of science policy just as he can understand the consequences of fiscal or foreign policy. But it is essential to distinguish clearly between two aspects of decision making:

1) GOALS — "What should be done?" This involves moral judgement of priorities and it is the responsibility of citizens as a whole.

2) METHODS — "How should it be done?" This requires the consultation and advice of experts who can draw upon knowledge and resources not available to ordinary citizens.

In this context it is well to remember that while the scientist has developed specific and powerful tools, he has often tended to reduce social problems to terms which can be handled within the framework of his techniques. This has resulted in shifting the focus of a problem to those mechanical or technical aspects that can be dealt within laboratories or by abstract analysis. Frequently these facets are of only marginal importance.

In the following presentation we will address ourselves to five aspects of the problems before the committee:

1) The present priorities as reflected in the current allotment of Federal funds.

2) The direct involvement of the Federal Government in the conduct of scientific research.

3) Scientific advice to Government and Parliament.

4) Science Policy and the citizen.

5) Canadian Research and the needs of the developing countries.

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1) PRESENT PRIORITIES AS REFLECTED IN THE CURRENT ALLOTMENT OF FEDERAL FUNDS

Canadian science policy has never been adequately debated in the House. Even during the discussions of the Bill to establish a Science Secretariat and a Science Council, matters of national priority were only peripherally mentioned. The most eloquent statement of de facto policy of our Government and its present priorities can be found in its budget. But even close scrutiny of spending estimates and supply motions can provide the ordinary citizen with only an approximate estimate of funds spent for specific projects or in specific areas, since many research expenditures are not labelled as such in the estimates. Nevertheless, such figures serve the purpose of indicating which phases of Canadian life the Federal Government considers worthy of active promotion.

As stated in the Glassco report, one of the most effective policy-making bodies in Canadian science is the Treasury Board. In Table II some basic figures are compiled. They indicate the predominance of Government support in two areas:

1) Investment in "defense-oriented" research.

2) Support of applied natural sciences as a means to improve the country's economy.

TABLE II*

OTTAWA RESEARCH SPENDING

Dept. or Agency	1968**	1967	1966	1965	1964
		- millions -			
Agriculture	48.5	40.3	36.8	33.4	30.6
Atomic Energy of Canada Ltd.	70.4	62.6	54.9	53.1	45.6
Dept. of Mines & Resources	84.7	65.0	52.9	43.5	42.3
Industry	53.9	27.2	24.3	20.5	19.0
National Defense	88.3	81.6	89.2	69.9	69.6
National Research Council	110.8	89.9	67.3	53.8	46.6
Transport	33.2	30.5	32.1	31.2	24.0
All Other	111.7	78.6	68.0	50.8	41.6
TOTAL	601.5	475.7	425.5	356.2	319.3

*Financial Post, 1st March 1969
**Estimated

SOURCE: DBS

For some time the Economic Council of Canada has been drawing attention to Government's role in supporting research and development related to innovation, production and utilization of natural resources and general economic development of the country.

The support of life sciences, social sciences and humanities in general has had less attention. While recent years have seen greater awareness of the needs in these fields, we must draw attention to the disproportionately small amount that has been spent in these areas. Even today the budget of the Defense Research Board alone - not counting the research expenditure of the Department of National Defense - is approximately 50 million dollars compared to the 20 million dollars available to the Medical Research Council for grants in aid of research, as shown in the data submitted to the Senate Special Committee on Science Policy.

Looking at priorities as expressed in allotment of funds, Voice of Women/La Voix des Femmes wishes to register basic disagreement with the preoccupation of the Federal Government with defense-oriented research and with the purely commercial and economic benefits in the development of our national resources. While fully appreciating that economic benefits can produce opportunities for work and gainful employment, we would strongly suggest that the preoccupations with economic returns do not adequately reflect the true needs and values of Canada today.

Looking at the research sponsored by Government funds, Canada seems to give far less care to pollution control and preventive medicine than to ore dressing and rock blasting. We can find money to build wind tunnels and learn as much as possible about stresses and strains in airplane wings, but we know little and seem to care less about the effects of sonic booms on the physical and mental health of people. We are willing to invest substantial resources for potential protection of our troops against chemical and biological warfare but we do not seem willing to

consign any resources to the application of organized intelligence to resolving the growing social conflicts in our country. Generous tax benefits are available to firms developing new products and the Department of Industry is ready to counsel and advise them, but individuals and agencies working in the social spheres for instance with alienated youth or first offenders, do not even have enough resources to compile adequate case histories or to conduct follow-up studies or to communicate with those having similar concerns.

2) DIRECT INVOLVEMENT OF THE FEDERAL GOVERNMENT IN THE CONDUCT OF SCIENTIFIC RESEARCH

Compared to other industrialized nations, the Federal Government of Canada and its agencies conduct a high proportion of scientific research "in-house". While we appreciate the historic reasons for this and realize that, twenty or thirty years ago, many problems could not have been attacked except by agencies supported directly by Government and that many Canadian scientists would not have found employment had it not been for institutions like the National Research Council and Mines Branch, yet we feel strongly that today there is no reason to increase or even continue the direct involvement of the Federal Government in any scientific research not immediately related to the business of governing the country.

Prior to the hearing of this Committee it was difficult to find documentation of the extent to which the Federal Government and its Departments conduct fundamental and applied research. Table III gives an approximate picture of the situation.

It shows the number of scientific and professional staff as well as the technical personnel involved in research activities in the various departments and agencies of the Federal Government. It should be noted that every one of these departments or agencies has increased its research budget and its facilities substantially during the last decade.

TABLE III

Employment of Scientific and Technical Personnel in Research and Development Activities of Federal Government Department and Agencies.

Agency or Department	Scientific and Professional	Technical	Source S*
National Research Council	890**	1020	p. 243
Defense Research Board	590	918	p. 382
National Defense	302	106	p. 598
Health and Welfare	650	302	p.1394
Energy, Mines and Resources	1084	1740	p.2496
Fishery	231		p.2780
Forestry Branch	534	675	p.2257
Agriculture	1083	964	p.1172

S* Proceedings of the Special Committee of the Senate of Canada on Science Policy.

**Including 181 post doctoral fellows.

We would urge this Committee to question seriously the propriety and usefulness of such large direct involvement of the Federal Government in scientific research. Looking through the annual reports and lists of publications of the relevant Departments, one finds many published papers dealing with fundamental research, and notices the building up of comprehensive research facilities. It is therefore hoped that the Committee will ponder the question as to what national purposes are served by this growing federal research empire.

The concentration of research in agencies of the Federal Government rather than in universities and learned institutions, industry and co-operative research groups, in hospitals and medical centres has a number of undesirable features. It isolates scientists within narrow specialized groups, depriving them of the contacts with students, of interdisciplinary stimulation; their work is rarely exposed to the same degree of scrutiny of the profession as is research at a university. The segregation of scientists into a social environ-

ment of civil servants tends to be reflected in their approach to research problems and one finds a deplorable lack of social awareness in many scientists who have been for prolonged periods in the employ of Government agencies.*

Furthermore it would be naive to overlook the danger of conflicts of interest that do arise when a government agency conducts "in-house" research in a field in which it also is the major source of extra-mural grants.

Voice of Women/La Voix des Femmes believes firmly that active participation in scientific research by the Federal Government should be devolved and the programs should be transferred to universities and other appropriate institutions. We take especially strong objection to the activities of the Defense Research Board, particularly in the field of chemical and biological warfare research. Because of Voice of Women's concern in Canada's involvement in chemical and biological warfare research, we have conducted a series of interviews with senior members of the Defense Research Board in order to have first-hand insight into the problem. We have visited Suffield and Shirley Bay, and have had an interview with the Chairman of DRB. Our views as a result of the visits are detailed in Appendix 2 of this submission. We have come to the firm conclusion that Canada must discontinue its research in this field. It should transfer its facilities to the appropriate agencies of MRC or NRC and use the expertise of staffs in those fields which need urgent attention, such as environmental pollution and preventive medicine. We can assure the Committee that it will be more and more unacceptable to an increasing number of Canadian citizens to see the resources of our country utilized for largely non-constructive purposes.

*FOOTNOTE: Observed as a result of a number of interviews which Voice of Women members, some of them scientists in their own right, have conducted throughout the years with scientists in Federal Government Departments and various laboratories of the Defense Research Board.

3) SCIENTIFIC ADVICE TO THE FEDERAL GOVERNMENT

On many occasions Voice of Women/La Voix des Femmes has submitted briefs to our Government. Our members have been in contact with Members of Parliament and with senior civil servants. These experiences have left us very concerned about the manner in which the technical expertise is chanelled into the decision-making process of the Government. Since we firmly believe that informed public discussion and parliamentary debate must precede the actual decision-making it seems to us imperative that the citizens know the pertinent facts as well as the source of the expert advice influencing policy decisions. This can be accomplished only if the scientific and technical advice on which the Government relies is given to the House of Commons and its committees. Only if adequate scientific information and counsel is available to Government and opposition alike is it possible to conduct a debate on a rational basis. If one accepts these premises, a number of features in the set up of the Science Council and the Secretariat need reexamination. The Science Council appears to us too heavily weighed toward technical and natural sciences and as Dr. Porter remarked before this Committee, the inclusion of social sciences would provide welcome inter-disciplinary cross-fertilization. In addition to this, we feel that members from the research institutions of the Federal Government are unduly dominating the Science Council. Most of all, we believe that expert advice of the members of the Science Council must be available to the House of Commons and/or its committees rather than the Government alone. The availability of reports issued at the end of a period of intensive studies is not a substitute for participation in discussions, and opportunities for questioning - all of which are at present not open to the elected representatives of Canada's citizens.

The essential request of citizens is that, whatever the machinery, scientific advice to decision making bodies be public, and that

all possible care must be taken to avoid creating a cast of technical experts within the Federal Government who would provide all successive governments with blueprints of narrowly defined options, thus effectively making national policy without being accountable to the elected representatives or to the citizens at large.

In this context, particular concern is felt about the increased tendency of governments to provide for themselves a monopoly of information. The vast financial resources which the taxpayer puts into the hands of governments, together with modern techniques of information processing and computerization can give central authority an unchallengable monopoly of information and knowledge.

Professor Porter put before the Committee the great potential advantages of informational and computer development, its efficiency and scope. Yet, one knows little about the ways in which to collect and correlate information without at the same time "managing" information and censoring and directing it. Any research and development into the technical aspect of information processing should be accompanied by an equally vigourous research program into the social and legal consequences of data collecting. We find it difficult to see how meaningful democracy can function without equal access of all to the sources of information. If any Government is in sole possession of all relevant facts, it is de facto beyond scrutiny and control of its citizens.

4) SCIENCE AND THE CITIZEN

An integral part of the responsibility of the Federal Government in the field of science must be the support of adequate information and interpretation of advancements in science in the broadest sense. During the past decade, various attempts have been made in the United Kingdom and the United States to form groups or to use specialist journals to bring important scientific developments to the laymen

particularly as they relate to national political decisions. In Canada, there exists little incentive for excellence in this field of public education. Only the largest newspapers in Canada have scientific correspondents. No Canadian magazine has a regular science column. "Science Forum" is primarily intended as a means of communication among scientists rather than as a service of information for the laymen.

We think it essential to foster the growth of adequate scientific interpretation relevant to Canadian decisions. We would welcome scholarships and rewards for competent scientific reporting, provision for journalists to take additional training in scientific writing as well as encouragement for young scientists to develop skills in the field of interpretive journalism. We see merit in the Federal Government support of seminars on University or University Extension level that would provide continuing dialogue between scientists and politically oriented citizens. We could envisage conferences between Members of Parliament and citizens in certain localities and the appearance of knowledgable experts to discuss priorities and implications related to projected government action. Such endeavour would fall well within the framework of federal science policy, as they would help in defining its terms and clarifying its goals. We would urge again that the Federal Government assume a sponsoring or co-sponsoring role rather than an executive one in encouraging science interpretation.

5) CANADIAN SCIENCE POLICY AND THE DEVELOPING COUNTRIES

If a science policy for Canada is to reflect national values and aims, our science activities must go beyond utilization of the benefits of science and increased knowledge to Canadians alone. Many of us feel strongly that we are a part of the family of man, privileged to live in a country with a high standard of living and aware of our dependence on the less industrialized nations. A number of research areas, some of them listed in Table I, are of particular interest to

developing regions; sponsorship and development of this type of activity may not result in tangible economic benefits for Canada in the immediate sense of the word, but consideration of this type of work is legitimate, necessary and an integral part of any government science policy. Such work not only produces necessary information but it also trains Canadians to greater usefulness. We are aware that the Canadian International Development Agency is thinking about these problems - we hope that the desire to conduct research for developing countries will not result in the creation of yet another Federal Government agency but in the establishment of research chairs at universities or colleges devoted to teaching and research in these fields. We would like to draw the attention of the Committee to the set-up of the Overseas Institute in Britain, a non-governmental institution which seems to conduct useful research in this area.

RECOMMENDATIONS:

We would like to present the following recommendations toward a revision of the present de facto priorities and towards the formulation of a new Canadian science policy:

1) Present heavy defense-oriented expenditure of the Canadian Government does not reflect the priorities and valued of the Canadian people. No new science policy should be formulated without public discussion and clarification of the goals toward which Canadian support of research and development should be employed.

2) We urge Canada to reduce the amount of public funds spent on defense research and on the development and production of military hardware for export. Instead, adequate funds must be made available for medical research, environmental studies and the social sciences.

3) We urge strongly that Canada discontinue immediately all research in the field of chemical and biological warfare, withdraw from all shared research programs in this field, request the transfer of appropriate facilities and use the knowledge of its personnel in the field of environmental research and preventive medicine.

4) We wish the Canadian Government to support scientists and their research rather than itself be a research agency. We request rapid withdrawal from research activity within departments of the Federal Government except when related directly to the mechanics of governing. Corresponding scientific activities should be carried out at universities and similar institutions, if necessary, newly created, to give the best possible opportunity for teaching, learning and interdisciplinary stimulation. *

5) In assessing the merits of projects, potential economic benefits must not take priority over social and human benefits. Due to past lack of support for social and life sciences and for humanities, Canada now is in need of a decisive and determined program to stimulate social innovation and experimentation. The quality of life and the restoration and preservation of the human environment are, to many Canadian, far more important than defense research and nuclear technology.

*FOOTNOTE: We are putting this recommendation before the committee, although we are aware of the problems it raises. An increased participation of universities and colleges in applied research sponsored by the Federal Government or by industry may be regarded by some as a danger to the independence of the universities. However, we feel that it is far more the method of sponsorship (i.e. whether a direct contractual dependence of the investigator on the sponsor is involved or the support of a university that would enable an institute to specialise in a certain field) than the subject of study that will determine the effect the inplications of this recommendation might have.

6) Discussions on science policies must involve concerned citizens and their elected representatives. Science advice should go to the House of Commons rather than to the government of the day. It should be given publicly and debated publicly. Since experts do not necessarily draw the same conclusions and arrive at the same predictions from a given set of facts, it is essential that the House hear and question scientists of differing opinions. Special parliamentary committees may be useful for this.

7) We urge the Committee to enquire thoroughly into the social, legal and moral implications of central data collecting and computerization, prior to recommending any such scheme.

8) We wish to recommend special attention to problems of science interpretation and to the establishment of awards and scholarships in order to improve the common level of understanding of technology especially as related to Canadian decisions.

9) We request the Committee to consider including into the responsibility of the Federal Government in the field of science, the allotment of adequate funds for studies of technical problems of particular importance to developing countries.

GOAL 1: NATIONAL PROSPERITY

Elements of the Goal[5]

—High rate of economic growth.

—Reasonable price stability.

—Equitable distribution of rising income.

—Viable balance of payments.

—Full employment.

—Reduction of regional economic disparities.

Contributions of Science and Technology

—Increased industrial productivity, without which the nation will not be able to afford to expand its attempts to deal with mounting social problems. Contributions to productivity in manufacturing industry are perhaps the most obvious, but improvements in productivity in Canada's primary industry should release manpower to still more productive sectors of the economy, and increased productivity in non-profit service industries (health care, education) is also needed to reduce costs.

—Innovation, in selected manufacturing and specialized service industries that have inherent comparative advantages in a Canadian setting to improve their competitive position in international trade.

—Continued improvement in the management practices in Canadian industry, for example by more extensive and effective utilization of computers by management.

—Improvement of the efficiencies of the services industries, particularly in distribution systems.

—Development of sound programs for the use, conservation and replenishing of resources.

—Development of techniques for rational decision-making on complementary activities, such as the balancing of different kinds of food production against each other, or in the choosing between the exporting of raw materials and the processing of those materials in Canada.

—Reduction of costs of many basic elements, such as energy, housing, transportation, communications, as a contribution to improving the standard of living and to the maintenance of overall price stability.

—The development and application of new technology, for example in improving communications and transportation systems, as a contribution to efforts being made to reduce regional disparities of productivity and income levels.

—Better understanding of motivational factors that influence industrial productivity.

BY "The world we hope for" I mean the world hoped for not only by the present generation to which I belong, but by future generations. Aspirations to a better world cannot be fulfilled in a single life-span, which is but a moment in the immensity of time.

The world we hope for, then, should bring:

Lasting peace: no more wars between nations or groups of nations; no expansionist countries using their superior material, military or economic strength to abuse or violate the rights of weaker countries; an end to the causes of strife within nations; no endless class struggles; international relations governed by clear, just principles which always respect the people's rights; a lasting peace, free from fear and oppression.

Concord and solidarity among all men: no infuriating disparity between those who make millions and those who have not even enough to feed their families properly. The sight for ever banished of the destitute begging for charity in the streets, when what they need, as our equals in rights, is work, a chance to improve their lot and to restore their confidence and faith in themselves. To be spared the sight of ragged children selling band-aids, tranquilizers and matches in public buses, when their parents should be the ones to work; and to be rid of the selfish and miserly whose very existence means that many of their fellow-beings go hungry. The benefits would be universal if men acted upon feelings of friendship and mutual respect, instead of merely paying lip-servise to them!

The spread of education and knowledge throughout every continent so that the light of learning may disperse the shadows of illiteracy. Education made available to all—an education no longer theoretical and largely divorced from life; all the cultural resources of society at the service of of the whole community.

The aim of teaching and education to be a training for life, providing instruction rooted in life itself and in the fundamental problems of the day. To this end, industrial and agricultural education should be developed and intensified, as should scientific and technological research. In other words, the aim should not be to make (or rather deform) to measure persons whose professional skills serve merely to plead the cause of privilege and to uphold the privileged; on the contrary, professional training should be dedicated to the service of society as a whole.

The printed word is the most powerful instrument of man's development: it satisfies the infinite thirst for knowledge and is unmatched as a medium of intellectual communication; it maintains the continuity of history and culture, the common heritage, animating force and living essence of a people, which it behoves us all, as cells of the social organism, to conserve, defend and cherish. Books train and cultivate the mind. All men must be educated and taught their civic rights and duties so as to enjoy a real freedom of decision, without the risk of being cheated or defrauded in their aspirations.

Study as a corner-stone of life, so that when literacy becomes universal, everyone may find opportunities of applying, in their community and especially in their work, all they have learned.

The promotion of science and technology, symbolic of the present and the future, to enable man to explore infinite space, and allow human intelligence to penetrate far and deep in its insatiable thirst for knowledge.

The Uruguayan scientist, Clemente Estable, addressing the Uruguayan

APPENDIX I A

SCIENCE COUNCIL OF CANADA

Towards a National Science Policy for Canada

Section 3

NATIONAL GOALS AS A FRAMEWORK FOR POLICY

Before the Science Council could construct a sound policy for the use and development of science in Canada, it had first to erect a frame of reference for this policy. Starting with the axiom that the value of any scientific enterprise to a society is determined by the social, cultural and economic goals that that society seeks, such a framework could be built in four stages, following in logical order:

(1) identifying a set of goals which, while not comprehensive, appeared to contain the main aspirations of most Canadians;

(2) identifying the various factors on which the ultimate attainment of each goal will depend; in most cases these factors can equally well be considered as elements of the main goal;

(3) identifying the contributions that science and technology can make towards the attainment of the goals; and

(4) identifying the conditions that will permit these contributions to be made.

Six goals were chosen to provide this focus for policy discussions:

—National prosperity.

—Physical and mental health and high life expectancy.

—A high and rising standard of education, readily available to all.

—Personal freedom, justice and security for all in a united Canada.

—Increasing availability of leisure and enhancement of the opportunities for personal development.

—World peace, based on a fair distribution of the world's existing and potential wealth.

It is not suggested that this list is in any way complete, nor that the short notes which follow make up an essay on national goals; the comments on each goal are provided only as a brief outline of the frame of reference for the recommendations which are made later in this document.

APPENDIX I B

A prize-winning essay from Uruguay

THE WORLD WE HOPE FOR

by Maria Cristina Costa Diaz

A regular programme on Uruguayan television, "The Questions of Man", is entirely devoted to themes from the "Unesco Courier". Last year, the programme's director, Señor Eduardo Adrian, and the Losada Publishing House in Montevideo organized a nation-wide essay contest for Uruguay's high school students on "The World We Hope For". We are pleased to publish here the text of the winning composition written by 16-year-old Maria Cristina Costa Diaz, a student of the Sacred Heart Institute, in Montevideo, whose prize was a collection of 30 books and a three-year subscription to the "Unesco Courier". Photo shows Señorita Costa Diaz with (on her left) Salvador Valle (second prize), and Juan Carlos Mondragón (third prize).

GOAL 2: HEALTH

Elements of the Goal

—Provision of medical services of rising quality and efficiency.

—Improvement of the environment in which Canadians live.

—Development and improvement of practices conducive to public health.

Contributions of Science and Technology

—Continued medical research to ensure that the standards of training and practice in Canada's health professions are of a quality that is high by world standards.

—Application of systems science to the provision of medical and other health services, particularly hospital care, to improve the efficiency of these services and to reduce their relative costs.

—Studies of individual and group behaviour in relation to physical and mental health.

—Improvements in the conditions of urban and rural life, to remove threats to both physical and mental well-being.

—Control of existing and threatened health hazards already created by the misuse of science and technology—*e.g.* pollution.

GOAL 3: EDUCATION

Elements of the Goal

—Opportunities for education of high quality, at all levels from elementary through to post-doctorate and including all forms of post-secondary training, should be readily available to all Canadians, to the limit of their individual abilities.

—Opportunities should be available for upgrading the education of adults, to assist those who have been by-passed in their youth and to allow others to keep pace with advances in their specialized fields.

Contributions of Science and Technology

—The continued provision of opportunities for first-class basic research in the universities as a vehicle for graduate teaching.

—Improvements to the quality of teaching at all levels.

—The application of the scientific method to studies of the current system of providing education.

—The introduction of a scientific curiosity-directed approach into all levels of education as a means of stimulating thought and creativity, and as a substitute for teaching by rote.

—The application of systems science and other techniques to the process of education, to increase its productivity.

Chamber of Representatives, which held a session in his honour on October 3, 1960, declared : "In our time, when even astronomy has become, amazingly, an experimental science, with artificial satellites and planetoids, scientific research is an absolute and imperative necessity, and any investment in such research is of great significance for democracy."

The paths of science and technology lead to the realm of energy, light and speed. A stimulus must be given to all speculative pure or applied thought (in philosophy or the sciences) and to every concrete expression of the concept of beauty (in the realm of the arts, whether sculpture or painting, music or literature.) The essential aim is to enhance the meaning of life through art, and thus hallow the triumph of spiritual over material things.

Increased production, and the abundance that will result from compulsory work, whose effects will be chiefly felt in the productive sectors; by planning and rationalization of production; by the contribution of technology; by economic development. All this should make for abundance; enough food for all, an end to malnutrition; lower death rates; prevention and eradication of sickness; the guarantee of a better life for future generations; a fair distribution of the national income.

The concept of work as a law of life, in accordance with the following principles: compulsion to work for all the mentally and physically fit; a normal work day to satisfy not only the needs but the reasonable and legitimate desires of all; elimination of social parasites so that each can and must live by his own resources, not by the effort and sacrifice of others.

Freedom from crime. The minds of men purged of criminal thoughts by vigorous campaigns of education and re-education from the social, psychological, moral, individual and professional viewpoints. Creation of economic and social conditions which will do away with the socio-economic roots of crime. Penal laws with humane and social aims that concord with the most progressive recommendations adopted by specialists at international congresses, always bearing in mind that a prison should not be a place of torment and retribution, but of re-education, rehabilitation and work. And measures should be taken to prevent criminals from buying immunity from the law through influence.

Proper housing for all. The "right to a roof" is a primary, elementary and essentiel right which must be guaranteed by the State. It is one way of giving self-respect to the citizen and promoting a better standard of living.

An end to man's exploitation by man, that appalling evil which still persists in various hidden forms: all men to be of equal standing, with neither exploiters nor exploited; work as a social force used to further the general interest, creating wealth for all; the fashioning of a new mentality, taking for granted that man should be the brother and friend of man, not his plunderer, and that everyone should support and help his neighbour.

Strong feelings of solidarity, deadened under the present competitive system, would be aroused, and "all for each and each for all" would acquire real meaning as a principle of work, with a full, human, fraternal relationship uniting all mankind as artisans of progress.

Full development of "fundamental rights". I will refer to only one of these: freedom. This implies, in institutional and material terms, the right of everyone to fulfil a vocation and to develop his personality; and in the expression and communication of ideas, the right to meet together and

—The development of advanced, computer-based educational aids, to increase the quality of the education being provided.

—At the secondary and higher levels, better understanding of student motivation, to allow educational procedures to be modified so that education can be seen as being directed to attaining appropriate goals for the individual and society.

—The provision of better information services for education.

GOAL 4: FREEDOM, SECURITY AND UNITY

Elements of the Goal

—Promotion of better understanding and co-operation between the different parts of Canada and between Canada and other nations of the world.

—Continued defence of the rights and safety of the individual.

—Improvements in the methods of crime prevention, detection and control.

Contributions of Science and Technology

In this case, much more than in the others, science and technology pose threats to society as well as conferring benefits. On the positive side lie contributions to:

—supporting Canada's national defence by providing the necessary military technology;

—expanding man's capacity to travel, to learn to co-operate, to foresee and guard against dangers and to summon help in case of need;

—improving communication between groups or regions of the country;

—the development of new techniques in criminology and forensic science as a contribution to the battle against crime.

On the negative side, science makes possible coercion, intrusion into privacy and concentration of power on an unprecedented scale. Strong political, moral and personal safeguards against these misuses of science are needed, and technology can contribute to these safeguards.

GOAL 5: LEISURE AND PERSONAL DEVELOPMENT

Elements of the Goal

—Reduction in hours of work and removal of need to perform menial tasks.

—Development of Canada's two principal cultures and of understanding between them to create an attractive and stimulating environment.

to form associations, freedom to express political, philosophical, moral and religious ideas of any kind and the right to exercise any profession or occupation, as well as to develop any manual, scientific or cultural skill.

Freedom of work, certainly, but also for everyone the right to work, to do an honest job without being exploited; and for the State, the duty to provide it. In short, freedom unimpeded by economic, social or political barriers.

Ethical principles put into practice, shaping man's thoughts and acts. Fulfilment of moral precepts established by general consensus; man's thinking and actions guided by pure and worthy motives.

Justice for all, giving to each according to his needs, encouraging each to give according to his abilities, wiping out oppression and the existence of privileged groups which place themselves above the law.

Achievement of real equality, as all will have the same rights and duties, and the same economic, social, political, cultural and vocational opportunities.

The reign of truth and sincerity with men speaking from the heart, in purity of intent and action, and an end to lying, hypocrisy and dissimulation.

Governments worthy of civically mature peoples: upright, loyal, honest defenders of the general interest; neither corrupt nor corrupting, nor venal; neither enriching themselves in office, nor betraying the people. Politics practised with a moral sense of civil guidance and conduct, without suborning or purchasing the conscience of men with money or favours; in other words, politics based on maturity and enlightenment, instead of ignorance.

The disappearance of existing colonies and the incorporation of their peoples in the concert of free nations. In our century of satellites and space rockets, in this atomic and thermonuclear age, colonies are a blot to be wiped from the face of the planet once and for all. We Uruguayans finally threw off all foreign yokes in 1828. Shame on the human race that colonies should still exist in our world today.

The world we Uruguayans hope for fits into the pattern already outlined (conceived not as a vision of tomorrow but of a future time), yet has some special features of its own.

In the reality we expect for Uruguay and the other Latin American countries, the following aims should be achieved: land must be put to better use, redistributed to serve the whole community, exploited rationally and with the help of modern technology; sources of employment must be created, as the only effective weapon to attack enforced idleness; commerce and industry must be planned to take account of national needs; the various branches of national legislation must be renovated and adjusted to current ways of life and to the pace and demands of our time.

Education and instruction must be available to all, with priority for those living in the countryside; a vast literacy campaign should be promoted, and school-building accelerated. Higher agricultural, industrial and technical education must also be developed.

All public services must be reorganized, to prevent the irrational distribution of specialists, technicians, office staff and manual workers. Their knowledge and ability should be used to the best advantage, with agricultural engineers and specialists working in rural agricultural schools, not in offices in the capital; and in general, all professional men, doctors, lawyers, architects and others should devote their efforts to the work for which they were trained.

—Provision of opportunities for culture, recreation and challenging personal endeavour.

Contributions of Science and Technology

—Satisfaction of man's compelling urge to explore, to know and to understand himself and his universe, which has long been a great source of cultural development, by the promotion of fundamental scientific research as one of man's highest intellectual and cultural achievements and as an expression of creativity of a sophisticated kind. It must be acknowledged that, to many scientists, this idea in itself would rank as a major goal.

—Increased Automation.

—Development of devices to perform menial tasks.

—Development of efficient, inexpensive transportation systems to permit easy travel.

—Development of advanced communications media, which will permit man to widen his horizons immeasurably.

—Development methods to facilitate more widespread Canadian bilingualism.

—Development of the accessories and hardware of modern leisure.

GOAL 6: WORLD PEACE

Elements of the Goal

—International peacekeeping and maintenance of world order.

—Contributions by the wealthy nations of the world to the development of less fortunate nations, particularly by the elimination of poverty and hunger in the short term, and by facilitating the development of self-generating and self-sustaining growth forces in the long term.

Contributions of Science and Technology

—Increasing effectiveness of foreign aid by bringing a complete range of scientific techniques to bear on the problems of specific developing areas.

—Increased understanding of the dietary needs of people in different areas of the world, linked to improved methods of producing the right kinds of food for the hungry of the world.

—Increased understanding of the problems and aspirations of other peoples of the world, through the increasing links in the scientific community such as the international agencies, societies and "International Years" for study of specific problems.

There are undoubtedly many contributions which science and technology can make to these goals which are not listed here, and there are some contributions which affect all of the goals. Among this latter group, one would include contributions to the understanding of population growth and of individual and group behaviour. Given this framework of goals and the need to apply science and technology to their realization, Canada needs an appropriate scientific infrastructure or environment. The Science Council believes that some of the basic prerequisites for success in achieving these goals are:

—an increasing awareness, on the part of the public, government and industry, of the value to society of science and technology, as important means of attacking economic and social problems;

—the effective application of existing scientific knowledge;

—a high level and standard of scientific and technological education as a precondition for upgrading the technical competence of all levels of the Canadian workforce;

—effective participation in the international scientific community, as a means of tapping a vast supply of knowledge;

—effective use of modern information technology and systems.

Having set out a list of Canadian goals and having noted a number of the prerequisites for establishing the kind of scientific environment in which Canada could hope to realize these objectives, the Science Council must add a note of economic caution. The resources necessary to realize these goals will be substantial and there will be competition between the goals for both manpower and funds in the foreseeable future. The maintenance of a prudent balance of the resources assigned to the various goals will be important. For example, if the allocation of money outstrips the available trained manpower in a particular area, money will be wasted. The reverse is also true. In addition, if health services are developed at the expense of education, the supply of trained minds to support all of the goals would be truncated. However, education must not only be a consumer of resources but must, on the long term, be an investment in the training of the kinds of manpower which will be needed. The Science Council will be considering this problem of resource allocation on a continuing basis.

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APPENDIX II

Summary of the report of the visits of Voice of Women/La Voix des Femmes delegations to Suffield, Shirley Bay and Ottawa.

Members of Voice of Women/La Voix des Femmes have become increasingly concerned about Canada's role in the chemical and biological warfare research effort of the NATO countries.

The war in Vietnam,which has brought the use of nerve gases on women and children as well as the destruction of crops by chemical agents, has given a sense of urgency and reality to this concern. Consequently, small delegations of Voice of Women members visited the Defense Research Establishment, Suffield; the Defense Chemical, Biological and Radiation Establishment, Shirley Bay; and the Chairman of the Defense Research Board, Dr. R. J. Uffen in Ottawa, in September and October 1968.

Voice of Women/La Voix des Femmes learned in all three interviews that Canada's research and development activities in the CBW field are of purely defensive character. They are carried out to provide protection against chemical and biological agents for Canadian servicemen under all possible climatic conditions. No consideration has been given to the protection of the civilian population.

When Voice of Women/La Voix des Femmes questioned an anticipated use of Canadian servicemen outside Canada, it was firmly stated that only UN peace-keeping operations have been envisaged. However, no UN request for such measures of troop protection or defensive research in this field has ever been received by Canada. (1)

From the interviews and the study of the literature it is apparent that Canada has given substantial financial and technical support to CBW research and testing during the last 20 to 25 years. This has provided Canada with a group of experts and very good research facilities , as detailed in the DRB Brief to the Senate's special

committee on science policy on science policy "p. 437 ff".

"CHEMISTRY GROUP" DCBRE is a group of chemists with the only Canadian expertise in the detection of chemical agents in air, water, food and soil and in the decontamination of skin, clothing and equipment.

"MICROBIOLOGY GROUPS DCBRE and DRES". These groups are unique in Canada in their knowledge of the detection, identification and behaviour of airborne bacteria.

It seems that most of Canada's work is an integral part of a wider US-UK-Australian-Canadian effort, by virtue of Canada's participation in the Technical Co-operation Program (TTCP). "This program is based upon an agreement between Canada, the United States, Australia and the U.K. to collaborate in defense science with the aim of improving the combined efficiency of the four countries and minimising duplication of efforts. It is probably our most important program at present." (Dr. Uffen, Senate proceedings, p. 272).

Voice of Women/La Voix des Femmes seriously questions the moral and legal propriety of Canada's participation in this program as far as CBW research and testing is concerned.

Canada signed and ratified the 1925 Geneva "Protocol for the prohibition of the use in war of asphyxiating, poisonous or other gasses and of all analogous liquids, materials and devices and biological methods of warfare". With the ratification Canada accepts the protocol as a part of International Law, binding alike the conscience and the practice of nations.

Canada appears to violate the spirit if not the letter of the Geneva Protocol when she is part of an arrangement that involves the exchange of classified and unclassified research results with the U.S. The U.S. has never ratified the Geneva Protocol and is at present supplying and using chemical agents, such as nerve gas, herbicides, etc. in the war in Vietnam. (2) (3) (4)

The Canadian co-operation with the armed forces of the U.S. and other NATO countries was particularly evident during the Voice of Women/La Voix des Femmes visit to Suffield. Here Canada seems to maintain major testing facilities, well beyond her own defensive needs. As already stated in the History of the Defense Research Board of Canada by D. J. Goodspeed:

"Much of the work done at Suffield, of course, is of a classified nature, for the facilities of the establishment have been used very freely by both of Canada's major allies. In 1950, for instance, after a lapse of some years most of the field trials of chemical warfare agents which were being conducted in the free world were done at Suffield. Throughout 1952 the chief emphasis at Suffield was on the testing of CW ammunitions for both the United Kingdom and the United States equipment. A new type of dynamic bursting chamber was constructed in this same year for the testing of BW ammunitions." P. 150.

Voice of Women/La Voix des Femmes objects to the present Canadian research and testing activities in the CBW field for the following reasons:

1) During the past years the world has witnessed the use of specially developed chemical agents by the U.S. in Vietnam (and the mental preparation of public opinion to accept their use as "humane"). We do not wish Canada to have any part in this development - not even by doing "unclassified" research and thus freeing resources in the U.S. to carry out more "classified" research and development.

2) Canada's continuing committment of financial and technical resources to "defensive" CB research creates the illusion that the protection of Canadian is possible and necessary.

3) The professional knowledge of the Suffield and Shirley bay staff is pertinent to some of canada's most pressing problems in environ-

mental pollution and public health. The existing resources could be far more useful if employed in non-defense research.

Voice of Women/La Voix des Femmes therefore calls for:

1) The termination of Canada's participation in all CBW research and testing, under TTCP as well as under Canadian sponsorship except when in open international scientific co-operation.

2) The transfer of the facilities of the Suffield and Shirley Bay installations to appropriate existing or newly created civilian research groups in the field of environmental studies and preventive medicine.

3) A Canadian initiative to create a UN pool of information on the protection against chemical and biological agents.

Around the world the activities in CBW research seem to increase in scope and size. (5) It has been pointed out often that is is not possible to make a distinction between offensive and defensive research in this field. (6)

It appears to us that those who intend the results of their research to be defensive can only achieve this aim by pooling their results on an international basis - such as a UN pool of information on the protection against chemical and biological agents.

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REFERENCES:

(1) Dr. Uffen to Voice of Women/La Voix des Femmes delegation, October 1969.

(2) Statement of McNamara before U.S. Congress, Toronto Globe and Mail, March 15th, 1967.

(3) Brig. Gen. J. Hebbeler, statement to U.S. Senators. New York Times and Toronto Globe and Mail, March 5th, 1969.

(4) Text of a petition of 5,000 U.S. Scientists to President L. B. Johnson, February 14th, 1967.

(5) U. Thant, Annual Report to UN General Assembly, Sept. 1968.

(6) Dr. B. Dixon, New Scientist, May 1966.

APPENDIX 199

EASTER ISLAND
RESEARCH PROJECT

SUBMISSION
to the
SPECIAL SENATE COMMITTEE ON SCIENCE POLICY

Submitted by:

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June 19, 1969

EASTER ISLAND RESEARCH PROJECT

In expressing our gratification at being invited to submit some comments to the Special Committee we should perhaps also record our appreciation of our position near the end of the line of such contributors; we have benefitted from insights and new perspectives derived from much of the now voluminous literature covering previous submissions.

The Canadian Expedition to Easter Island was unique in many aspects ofCanadian science policy and many firsts were recorded. To mention a few of them:

1. It was the first major biological field study to achieve scientific cooperation between the Canadian universities and the Armed Forces.
2. It was the first multi-disciplinary study outside Canada to include both the physical and behavioural sciences.
3. It was the first medical expedition organized to study an isolated area with modern scientific equipment.
4. It was the first simultaneous biological examination of an entire population and their ecology.

One could enumerate other firsts in many areas of scientific

and human endeavour, but these may be the major ones. The Expedition was organized at the time as a pilot project in connection with the forthcoming studies of the International Biological Programme - a project which has not materialized on the scale planned, due to world political tensions. The three basic objectives of the Expedition were:

1. To conduct a multi-disciplinary study of the Easter Island population prior to termination of their isolation due to the construction of an airport.
2. To study the methodology of biological sampling under primitive conditions, using modern scientific equipment such as freeze-drying apparatus for blood samples, low-temperature equipment for the preservation of viral cultures, and the like.
3. To develop a model for studies of underdeveloped areas of the world - with the active cooperation of the local populace.

One of the most frequently asked questions in connection with the Expedition was why these studies were not conducted in Canada, say in an isolated Eskimo settlement. There are good reasons for that. First of all, there is mobility to and from even our most northerly settlements, whereas the Polynesians on Easter Island have lived in almost complete isolation for

centuries. Secondly, with the subsequent massive influx of construction workers for the airport there and the continuous coming and going from all parts of the world which the air age has brought to the islanders, we were provided with an ideal dividing line for before-and-after studies of the biological effects of western civilization. Third, but not the least, we wanted to provide Canadian contribution and leadership in an international effort which included scientists from Chile, Norway, Sweden, Switzerland, U.K. and U.S.A. Canadians have participated in many international undertakings, but this was indeed the first research effort conceived, carried out and followed up by Canadian initiative.

Perhaps rather than discussing the impact the Expedition had on the International scientific effort, one should mention that the Expedition was a total success. Every native on that island was thoroughly examined and 'sampled', providing a base-line for later studies, as well as valuable material for the biological sample bank of the World Health Organization which originally sponsored the Expedition. Those interested in the technical results are referred to numerous scientific publications in the various disciplines participating. Perhaps equally important from the point of view of international research in underdeveloped areas is the fact that we established an excellent relationship with both the native population of Easter

Island and the Chilean Government authorities, who became fast friends of Canada. The Expedition had a happy ending with the establishment of the Donner Biological Station, supported by the Donner Canadian Foundation, which now serves as the hospital for the island as well as laboratory facilities for visiting scientists.

The members of our Evaluation Committee have studied the submissions previously made to the Committee on Science Policy, and, for the purposes of this short brief, we feel that we should limit ourselves, in our comments on experiences on Easter Island, to those which have some direct bearing on national science policy, but which have perhaps not been elaborated in previous submissions. These fall into three areas:

I Canada's role in the international research and development.

II Inter-disciplinary research.

III Stochastic approach to research.

CANADA'S ROLE IN THE INTERNATIONAL RESEARCH AND DEVELOPMENT

The success of the Expedition has proven that Canadian undertakings, of a development as well as research nature, have a real potential in the international field. (Mr. Maurice Strong, on behalf of the Canadian International Development Agency, supported this point with a valid contribution in reference to international development programs.)

Bearing in mind the basic differences between research and development and avoiding the temptation to class as research certain investigative work which should be recognized as development (a tendency which has increased with the new popularity of "research" since the Russians launched their first Sputniks), we would recommend to the Committee two basic roles for Canadian scientists abroad.

1) Developmental work of an economic, sociological and technical nature, in regions where there is a real need for the type of work contemplated, carried out by scientists thoroughly trained for these activities and qualified to represent Canada. Apart from our natural altruistic motivation, this can be Canada's most effective international public relations function.

2) Research by Canadian institutions and groups outside of Canada in areas where conditions and local data are more suitable to the research than can be found at home. Research scientists may also become effective ambassadors, but this is apt to be very much a secondary function.

INTER-DISCIPLINARY RESEARCH

Recent experience, especially in the universities, indicate increasingly that the old, rigid separations between disciplines are no longer valid in present day research. By and large, the

outstanding research scientists in this country are those men who have crossed inter-disciplinary barriers,having developed a methodology which enables them to work best in teams of men in allied disciplines. They cannot achieve the same results by merely expanding their own fields of knowledge; no-one today can expect to master throughly electron-microscopy and biochemical analysis because each field is far too complex.

One of the advantages of a project like Easter Island is that so many of one's terms of reference are new ones; one's perspectives are all changed - and in freshly sharp focus. The need for interdependent disciplines was obvious from the start. Some of the problems seemed insurmountable at first, but the absence of any established method of dealing with them was an advantage. The problems in one's own environment are often harder to recognize. The need for some interdependence between different disciplines is becoming clearer all the time,particularly with industrial research operations showing the way. But in the university there is the problem of how to lower barriers between faculties without breaking down existing departmental divisions and interfering with a desirable degree of consistency in the subject matter taught.

Easter Island proved the need,and indicated that there are two kinds of solution:

1) <u>Gradual reorganization of research departments</u>, in

whatever ways are feasible to permit increasing interplay between any related disciplines.

2) Simultaneous development in the scientific community of independent research teams or organizations, preferably separate from current government, university or industrial bodies. Easter Island produced its results partly because of its separation from traditional operating methods and organization. We are convinced from this experience that there is a vital need for independent units of this sort to tackle projects which are totally nonaligned to existing research facilities and which do not indicate at the start what area of the community they will ultimately benefit most. These units will tackle projects which are tangential off-shoots of priority projects in other spheres of guided research, or which have been dropped in the past because of lack of specific orientation of initial results, or which result from the units' own original investigations. From time to time, one or another of these projects will take on (wholly or in part) an orientation to a specific industry or to a sphere in which government or university research is interested; such a project will be turned over to the specific discipline most likely to benefit from it.

Perhaps we should submit a few random examples of projects which might be undertaken because of their basic

inter-disciplinary nature and which may require unusual solutions.

- The problem of extinguishing of major (refinery,forest, etc.) fires by new methods of chemical soffocation control.
- Application of stochastic methods to psychological factors in research management.
- Application of pipe transport of solids to arctic ice.
- Sociological use of subliminal sound effects.

STOCHASTIC APPROACH TO RESEARCH

The academic and industrial communities are vitally interested in obtaining the greatest possible utilization of the personnel involved in research and exploratory development. Both these communities are governed by either adaptive or authoritarian systems. As a result, the nature of these communities is such that it does not stimulate the advancement of non-conventional ideas in scientific research. In the academic community this is largely due to the demands of other commitments,mainly teaching. The industrial community is naturally oriented toward obtaining the most favorable return on investment.

In recent years,however, industry has begun to see the need to substitute, for the traditiona,structured,authoritarian management,

a form of team mangement by cooperative self-control in the integration of individual and organizational objectives. Successfully embodied in, for example, the Scanlon Plans in the United States, and well documented by such sociologists as Douglas McGregor, the method has been found even more applicable to the field of research -- perhaps especially on Easter Island. This approach, which we have called "stochastic" (with, in this case,the human element becoming the constructively unpredictable factor), arouses, and constantly rekindles, a vital, inter-disciplinary involvement. By means of its dynamic organization of individuals, where certain standards and values -- for both the organization and the individuals -- are agreed on, each scientists can pursue what to him seems the best of the inevitable choices without having to await approval for each decision. The empirical-adaptive program does permit problem-solving by accumulation of changes, but it discourages a totally "new" approach and exercise of the unique capacity of the human mind for inductive reasoning, and is therefore a hostile environment for a "break-through". Surely all innovations and key ideas have come from men whose minds were free to probe.

The recent policy report of the Science Council of Canada, "Towards a National Science Policy for Canada" recommends that a multi-disciplinary approach be followed in the solution of important national problems. If such an approach is to be of optimum efficiency

in Canadian research activities, there should be a perfect entente between the various disciplines that can be brought to bear on a given problem, not only at the coordinating (government) level, but also at the various operating levels down to the researcher himself. Ideally this might be conceived of as a grid-like structure wherein two types of liaison predominate, vertical, i.e. standard line-organization, and horizontal, i.e. multi-disciplinary communication.

It is suggested that such research must aim also at providing an inter-disciplinary approach in finding original solutions for a variety of problems. Our experience leads us to the conclusion that this team approach on a scientific level can most effectively be achieved in an independent, preferably residential research establishment with scientists in many different disciplines in residence for varying lengths of time (depending on the duration of their particular projects - or financing). Their discussions should take place on organized, as well as hap-hazard, bases, giving each scientist in turn the benefit of prepared and random commentaries and free-for-all cross-pollination on the prospects and emerging results of his research, thus inhibiting his tendency to narrow his sights and lose perspective, and enabling him to maximize the potential from his project.

Such institutions do exist in other countries-e.g. the Rand Corporation and the Hudson Institute in the U.S.A.- which perform

a most useful function. As non-profit organizations they draw their financing from private foundations and from contract activities subsidised by their governments and (often cooperatively) by their countries' industries.

CONCLUDING COMMENTS

1) Canadian initiative in organizing and carrying out a multi disciplinary expedition to Easter Island has demonstrated that the combined effort of various scientific groups, including universities, industry and government (armed forces), is capable of making a significant contribution to the international scientific effort from both research and development points of view. Such efforts should be expanded, not only because of their scientific value, but also as a means of enhancing Canada's image abroad.

2) A need exists in Canada for a new approach to research along the so-called stochastic and interdisciplinary lines and for research centres embodying these principles, as an effective supplement to the research activities of the Government, the universities, and industry. Such research centres, eventually self-supporting (as recommended by the Science Council in (b) on p. 24 of the above-noted policy report), would also be free of the dangers of obsolescence or self-interested perpetuation beyond the useful course of specific projects because of its principle of constant turnover of different projects.

APPENDIX 200

Submission

to the

SPECIAL COMMITTEE ON SCIENCE POLICY

of the

SENATE OF CANADA

by the

CANADIAN COUNCIL OF FURNITURE MANUFACTURERS

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Ottawa
February 28, 1969

THE CANADIAN COUNCIL OF FURNITURE MANUFACTURERS

The Canadian Council of Furniture Manufacturers is a federation of regional furniture manufacturers' associations. Its member organizations include the Quebec Furniture Manufacturers Association, the Canadian Furniture Manufacturers Association (Ontario), and the Manitoba Furniture Manufacturers Association.

The Council is administered by a Board of Directors, whose members are elected from among the regional associations on a representational basis. The Council is recognized as the national organization of Canada's furniture manufacturing industry. There is no other national association within the industry.

THE CANADIAN FURNITURE MANUFACTURING INDUSTRY

The furniture manufacturing industry is one of the few remaining industries in Canada to be owned and controlled primarily by Canadians. Foreign ownership within the industry is comparatively small in relation to total production, and is estimated at less than 10 per cent. The industry is located from coast to coast and its factory shipments total more than $600,000,000 annually.

The industry employs directly more than 40,000 Canadians, and the wages and salaries paid in the key manufacturing centres are generally higher than those paid in comparable furniture manufacturing centres in the United States. Furniture manufacturing is considered to be one of the leading industries in respect to product labour content.

Some 95 per cent of the companies in the industry produce less than $1,000,000 worth of goods each, annually. It should be noted, however, that many of these companies are located in non-industrial centres, and their contribution to the employment and economy of their areas is important.

EXTENT OF TECHNOLOGICAL DEVELOPMENT WITHIN THE INDUSTRY

The furniture manufacturing industry is not concerned primarily with basic research, but rather with technological development. We do not believe that basic research is an industry requirement at this stage, although it may well become an outgrowth of certain work at the developmental level in the years ahead.

Our ultimate objective is to increase productivity through technological development, referring specifically to improvement in all production areas at the manufacturing level. This includes information, education, testing, standardization and quality control procedures.

With the exception of work being carried on by some of the larger manufacturing establishments, technological development programs at the company level are minimal. The reason for this is that the majority of our companies do not have the sales volumes required to underwrite individual developmental programs.

In an attempt to meet a tangible need in this area, the industry has embarked on collective programs through its various associations. These include:

1. The establishment of technical training schools at Victoriaville, P.Q., and Kitchener, Ont., in collaboration with the provincial governments concerned. Object of these schools is to meet the industry's needs for technically trained personnel.
2. In-plant training programs, as a means of assisting companies to meet their internal technical needs.
3. Technical seminars to bring to the attention of our companies the newest applications in furniture manufacturing technology.

4. Liaison with government departments and agencies responsible for research and development programs.

EXTENT OF GOVERNMENT ASSISTANCE

Various Federal Government departments offer assistance to the industry, and our experience is as follows:

Department of Industry, Trade and Commerce. The Wood Products Branch of the Department of Industry, Trade and Commerce, has been of considerable assistance to our industry over the years. It has worked closely with our Council on the achievement of many of our technical developmental programs.

Unfortunately, major industry programs, such as the Program for the Advancement of Industrial Technology (PAIT), and the Industrial Research and Development Incentive Program (IRDIA), have not proved of direct benefit to our industry. These programs, aimed at helping all industry to upgrade its technology, have not been applicable to furniture manufacturing in general or at least our companies have not been able to take advantage of their provisions.

Department of Fisheries and Forestry. The Forest Products Laboratory of the Department of Fisheries and Forestry has for many years now undertaken research and developmental projects which have been of direct benefit to the wood segment of our industry. Through the establishment of its Research Program Committee on Furniture, liaison between the laboratory and our industry has been strengthened to a marked degree.

Much of the work undertaken by the laboratory for our industry has involved projects such as bond quality evaluation tests for glued lumber panels, drying of lumber, dimensional stabilization of veneer by chemical treatments, among others.

More extensive work in the overall area of industry technological development, however, has not been possible because of the limited funds available to the laboratory.

Department of Manpower and Immigration. Through its Activities' Development Branch, the Department of Manpower and Immigration has been working closely with our industry. The main task has been in the area of improving the industry's employment sources of technical manpower.

National Research Council. The Technical Information Service of the National Research Council has embarked on a program to facilitate the flow of available technical information to Canadian industry. This service has been extended to furniture manufacturers, but on a limited scale.

THE INDUSTRY'S REQUIREMENTS

During the past two years, there has been a marked growth within the furniture manufacturing industry, particularly in the area of productivity. This has brought with it an increasing awareness of the long term problems facing our companies, and recognition of the need to find effective solutions to these problems. Technological development is the basis for this new technical orientation.

A growing trend to larger corporate units within the industry, through mergers and acquisitions, means that more companies will be able to meet their technological needs internally. But there will always be a majority of companies which have neither the technical manpower nor the financial resources to devote to technological development.

The industry's requirements come within the following definitions of your Special Committee:

Testing and Standardization. One serious lack within the industry is adequate testing facilities. It would be most helpful to have central laboratory facilities to which a manufacturer could submit materials, product applications and manufacturing processes or problems for study. This could be in the form of a pilot plant or a laboratory with specialized testing equipment, staffed by trained personnel.

Another important area is that of structural design from the engineering standpoint, to establish maximum strengths for various product applications, including basic details for furniture construction. Such testing facilities would lead directly to the formation of technical standards for the industry and improvement in quality control procedures.

An allied problem facing the upholstery segment of our industry is the lack of national standards covering textiles used in upholstery manufacturing. Some mills have established testing facilities but this is not prevalent and applies only to their own fabrics. A few of the larger manufacturing companies have installed their own testing facilities for fabrics, but again this is on a limited basis.

While the quality and wearability of such fabrics is a problem from the consumer standpoint and thus related to marketing, the required solution is a technological one. It would be a major help to the industry if fabric testing facilities could be established on a national basis to provide manufacturers with standards against which they could assess the fabrics produced by the mills for this purpose.

Technical Information. At the present time, there is no central clearing house for the dissemination of technical information concerning furniture manufacturing. There is a need for an extensive technical library covering equipment, materials and techniques, for use by the

companies within the industry.

In addition, there is a need to collaborate at the technical information level with research and development centres in other countries. A central clearing house for technical literature would serve as the basis for such collaboration.

<u>Education</u>. There is a shortage of technical personnel within the industry. Through our Council, however, the industry is taking steps to meet this requirement, as was mentioned earlier.

The establishment of central laboratory facilities and a central clearing house for technological information would help to provide a climate more conducive to attracting technically trained personnel to the industry.

<u>INDUSTRY RESEARCH IN OTHER COUNTRIES</u>

European countries in particular have looked upon technological development within their furniture manufacturing industries as a key to productivity and economic development. As a result, some have established centres for the furtherance of developmental research and the provision of technical information, usually under a joint partnership between government and industry.

One notable example is Great Britain, where a Furniture Industry Research Association was founded in 1961. This is a co-operative body, financed jointly by government and industry. The association's two main functions are research into the basic technical problems of furniture manufacturers, and the provision of information on developments in furniture technology.

The association also works on the establishment of standard test procedures which are incorporated into the standards produced by the

British Standards Institute. This work is undertaken in a fully equipped laboratory, set up in 1964 with assistance from the British Government.

In another case, Denmark has established a research institute for furniture under the Furniture Control Department of the Technological Institute at Copenhagen. It maintains close liaison with furniture manufacturers in the area of production standards and quality testing.

The institute is financed jointly by the Danish Government and the industry to 65 per cent of budget. The remaining 35 per cent of revenue is obtained largely from testing and other fees paid by manufacturers.

RECOMMENDATIONS

Based on the foregoing, we believe that the industry's technological requirements can be met effectively through the formation of one or more technical research and information centres. This could be in the form of either one main centre at a convenient location, or two centres located at the furniture schools in Ontario and Quebec. Such centres would be staffed by qualified technical personnel, to work in the area of technological development for the furniture manufacturing industry.

Such centres would, among other activities:

1. Maintain technical library facilities on a comprehensive scale.
2. Establish and maintain liaison and an exchange of technical information with comparable research centres in other countries.
3. Answer technical enquiries from manufacturing companies.
4. Conduct short term research projects on behalf of manufacturing companies.

5. Test materials provided by the supply industries and by furniture manufacturers, upon request.
6. Provide short term technical consulting services.
7. Establish standards for materials, techniques and finished products.
8. Establish fabric testing facilities for use by both upholstery manufacturers and the mills.
9. Maintain liaison with the Forest Products Laboratory of the Department of Fisheries and Forestry on the more basic research into the use of wood and wood products in furniture manufacturing.

There are two viewpoints as to whether it would be preferable to have a single technical research and information centre, or to establish centres at each of the two schools in Quebec and Ontario.

By establishing such centres adjacent to the schools, it would bring the research and technical information functions into the educational institutions. This would produce the added benefit of attracting research technologists to the schools and serve as a greater incentive to the students. A centrally located technical research and information centre serving all of Canada, on the other hand, would avoid duplication of work which could occur in the two centres.

To establish such centres, a grant would be required for the buildings and equipment, and to maintain the technicians and their supplies for a reasonable period of time. Testing fees would be charged to manufacturers for the work conducted by the centres on their behalf. This would produce revenue to help defray operating costs.

It is recommended, therefore, that technical research and information centres be established with the financial assistance of the government and as a joint undertaking between government and the industry.

CONCLUSION

The furniture manufacturing industry produces some $600,000,000 worth of goods annually. It is owned and controlled largely by Canadians. Its contribution to the economy is significant, both in terms of employment and the fact that many companies are located in non-industrial areas.

It is essential that the industry's productivity be maintained and increased through improved technology. While the industry is large in total, most individual companies do not have the sales volumes with which to underwrite individual developmental programs. Any approach to the industry's technological requirements must be at the national level on a collective basis. The industry is meeting some of its requirements through the work of its associations, but this is primarily in the area of manpower.

There is no central source of comprehensive technical assistance and information available to the industry in Canada. While government departments are helping and working with the industry, funds for this purpose are not adequate to meet the industry's overall technical requirements.

Certain governments in other countries recognize technological development within their furniture manufacturing industries as vital to productivity and the industry economy. Some have established centres

for developmental research and technical information under a joint partnership with industry.

Canada's furniture manufacturing industry has not been able to take advantage of government programs aimed at helping industry in general to upgrade its technology, such as PAIT and IRDIA. Other Canadian industries have had this advantage.

We recommend that the government assist the furniture manufacturing industry in establishing technical research and information centres to meet the industry's technological requirements.

Respectfully submitted,

Canadian Council of Furniture Manufacturers.

Ottawa,
February 28, 1969

APPENDIX 201

SUBMISSION

TO THE

SENATE SPECIAL COMMITTEE

ON SCIENCE POLICY

by the

CONSUMERS' ASSOCIATION OF CANADA

100 Gloucester Street,
Ottawa 4, Ontario

March, 1969.

1. The Consumers' Association of Canada is a non-political, non-sectarian, non-profit organization to which all consumers in Canada may belong. The objectives of the Consumers' Association of Canada for the past 21 years have been to unite the strength of consumers, to improve the standards of living in Canadian homes and to help the consumer receive full value for his money through education and knowledge.

2. In performing its function of providing information to the consumers of Canada, CAC has constantly been impressed by the quantity of significant data available and by the inaccessibility of such data to the Consumer. CAC has endeavered to reduce the huge gap between the study and research in areas of consumer interest that has been done but CAC is convinced effective utilization of research depends on significant changes in Canada's science policy. In this brief CAC directs attention to three major areas where deficiencies are most obvious.

A. Co-ordination of research presently underway,

B. Availability of research results to the consumer,

C. Specific areas where extended research is needed in Canada.

A. Co-ordination of Research

3. CAC has found considerable research is being done in many subject areas of direct concern to consumers in Canada. However there seems to be no efficient mechanism to co-ordinate the results of this research in each subject area or between related subject areas. Therefore it appears energy and money are wasted on research which has already been done or is in process elsewhere. Most research is piecemeal, projects tending to be concentrated on one small aspect of a subject area rather than taking the wider scope of the total subject area. Research is also limited in scope by the funds available and by the point of view of the individual researcher. Co-ordination of research involving an inventory of existing projects could contribute to establishments of priorities critically needed by governments at various levels, private institutions and universities to avoid wasting Canada's scarce resources for research.

B. Availability of Research Results to the Consumer.

4. The nature of CAC work involves continual contact with the public. CAC has found many times that the average citizen has little knowledge either of the areas in which research is being done or of the scope and direction of that research even when government sponsored. Indeed, at times CAC has, in the course of its work, encountered significant pieces of research which could be available to the public. However the public does not know what to ask for even if they do know that something has been done in a particular field. This means that the potential usefulness of much research is not exploited. The valuable information function of research appears to be entirely neglected. Attention should be given, in formulating science policy, to this problem of supplying data to the consumer in easily understood terms and presenting the data in such a way that the public could not misinterpret the results. CAC has found the Canadian consumer's interest in securing information to be steadily increasing. As the level of education of Canadians rises it can be anticipated such interest and demand for authoritative data will also increase.

5. Within this problem of making research available to the public, the position of government agencies of remaining secretive about research done with public monies requires comment. Even if all studies vital to Canada's role in the international world were excluded the vast amounts of research done for internal work could be made known to Canadian consumers. Aside from the utility of excellent information to the individual consumer such a policy would help the people of Canada to understand where their tax dollar is going and perhaps reduce resentment of government expenditures.

C. Specific Areas where Extended Research is Needed in Canada.

6. There are two basic areas of major concern to CAC and the consumers of Canada which need thorough investigation at this time, social and behavioural problems and economic and market problems.

7. Social problems are compounded by the steady movement of people to the cities where housing, transportation and the crowding together of many different types of people already present problems insoluble on the present knowledge base. Little has been done to even outline the

dimensions of the problems let alone provide the solutions. Why do welfare families beget welfare families? Is crime really increasing or has reporting to the public improved? What role does regional disparity play in our people problems? What is an 'adequate' standard of living? Is there no way to distribute public monies for assistance programs on a just basis?

8. A preponderance of science scholarships available in Canada are for the natural sciences, not the behavioural and social sciences. If the quality of living in Canada is a major concern, emphasis in science policy should be shifted so that the natural and social sciences are given at least equal importance in research.

9. Economic and market research is the 2nd area in which CAC feels extended research is needed. From the experience of constant contact with the marketplace CAC is aware of the lack of unbiased and useful information for the consumer in today's economic jungle. It is essential that research be undertaken to discover methods for making available to consumers the criteria for decision which the market place does not automatically supply - and appears even to withhold. At the present time, due to uninformative and excessive advertising, high-pressure selling, merchandising practises and the shortages of unbiased information, the consumer is handicapped in making an informed choice. This is particularly serious for the low income consumer where the effective use of each dollar is critical.

10. Research can produce enormous changes in the physical possibilities open to man but so far has revealed little of the social or psychological implications of that change. Research and advertising in consumer goods have the effect of carrying production and tastes in directions which have both specific and general social and personal overtones to consumers; there is no way, at the moment, of knowing just what these directions are or what they imply in terms of welfare or social overtones. Marketing procedures insure that the products of research will be used in a variety of ways. Because the consumer does not understand the implications of this extensive use of research undertakings, he must accept them; he does not know whether he would like to alter them or even what alternatives are available individually or in society.

Advertising in consumer goods tends to focus attention on personal luxuries and satisfaction. It also directs the attention of consumers to easy-to-use and highly manufactured goods thus presenting the possibility that the primary and secondary production levels will become less powerful in the marketplace. This is clearly an area which demands more investigation.

11. Another aspect of the marketplace which is a major concern to CAC is the problem of indebtedness. Why do people become over-indebted? How do they solve this problem or do they solve it? What is the effect of interest charges on purchases? Is there any effect? How do people in different income groups earn their money and how do they spend it? How does wide income dispartly and unequal opportunity affect the market process? Detailed research is required to answer these questions and to provide guidelines for changes in attitude and spending patterns.

12. During recent years CAC has become increasingly concerned that so little has been done to co-ordinate research projects throughout Canada or to establish a priority listing of the research which needs to be done. Co-ordination and establishment of priorities would not be enough. People also need to be informed, in terms they can understand, of research projects and results.

13. Scientific and technological research have advanced more rapidly than society has been able to assimilate the results. CAC maintains that research in social and economic problems, both of which cover a vast range of topics, needs to become a priority item in order that the proper balance between science and society may be preserved. A complete inventory of research in these fields should constitute the basis for decision concerning future direction of such research in the universities, private institutions and government.

APPENDIX 202

THE CANADIAN INSTITUTE OF MINING AND METALLURGY

V I E W S O N S C I E N C E P O L I C Y

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A Brief Submitted to the

Senate of Canada

Special Committee

on

Science Policy

Montreal, P.Q. June 1969

PREFACE

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This brief, compiled from written opinions offered by interested members of the Institute, presents recommendations on the following matters:

I AREAS OF RESEARCH

- Methods of locating mineral deposits
- Transportation
- "Urbanization" in mining areas
- Improvements in mineral processing
- Factors influencing more extensive fabrication in Canada

II STRUCTURE OF INDUSTRIAL RESEARCH AND DEVELOPMENT

- Incentives to reorganize practical economic character of industrial research
- Review in depth of IRAP, DIR, IRDIA, PAIT
- Possible introduction of "Industry Programmes"
- Industry-university relationship

III ADVISORY COMMITTEES

- Modification of membership of Science Council of Canada
- Establishment of an Advisory Committee on Science and Technology

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THE CANADIAN INSTITUTE OF MINING AND METALLURGY

VIEWS ON SCIENCE POLICY

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INTRODUCTION

1. Under the terms of its Charter, granted 71 years ago, the Canadian Institute of Mining and Metallurgy is expected to: " .... promote the arts and sciences connected with the economical production of valuable minerals and metals .... " and, " .... take concerted action upon such matters as affect the mining and metallurgical industries of the Dominion of Canada.". It is in the spirit of this objective that the following memorandum is submitted on behalf of the more than 7,500 members of the Institute.

2. The Canadian Institute of Mining and Metallurgy does not consider itself a professional body in the legalistic sense of controlling the right to practise engineering but as a strong technological and scientific society embracing the many fields and disciplines associated with the discovery, production, fabrication and exploitation of minerals, metals and fuels. The Institute counts among its members all the leading professionals in this broad area in Canada.

3. Because the mineral industry is so largely dependent on technology and the underlying science from which technical advances arise, the elements of national policy that may influence the extent to which science and technology flourish, the character and quality of work that may be undertaken and the degree of emphasis that may be placed on certain disciplines are of vital concern to everyone associated with it. Perhaps most concerned are the professional scientists and technologists within the industry upon whose skill, judgement, technical capability and

enterprise the economic success of any undertaking and, indeed, the entire industry depends.

4. At the risk of repeating much that has already been said, but with a view to emphasizing some points that are of particular interest to members of the Institute, the following topics are discussed briefly and recommendations relating to them are submitted:

RESEARCH AREAS OF MAJOR IMPORTANCE

5. The mineral industry in Canada, as elsewhere in the world, is characterized by some features that differentiate it from all other economic operations based on the exploitation of natural resources. Chief among these features are:

6. --- Most mineral deposits are difficult to find: the convenient, high-grade, easily accessible ore bodies have long been known but, for the future, discovery will depend increasingly on the sophistication of methods of detecting "hidden" mineral deposits even to the extent of using sensing devices located in satellites.

7. --- Mineral deposits are expendable and the various factors that enter into determining the desirability or economic worth of exploitation are profoundly influenced by this characteristic.

8. --- Minerals must be exploited where they are found, usually far from the location where they will finally be used. Many minerals - iron ore, coal, sulphur, limestone, etc. - have a value much less than 1¢ per lb. and, if they are to be produced economically, must be moved at the lowest possible cost to their final destination. Thus the means and costs of transportation are vitally important in the mineral industry.

9. --- The fact that mines are usually in remote areas and that each deposit has a limited life poses serious problems in respect of employment and housing. Despite the enlightened

approach of mining companies and the substantial expenditures they have made on housing and other amenities, much still remains to be done in the area that might be termed "urbanization" in the mining communities.

10. --- Many new ore bodies that are found are either low-grade or complex: in an era when costs of all kinds are rising inexorably it is essential, if the industry is to survive, that new, simpler, more economical processes be devised for producing metals and other mineral products from the raw materials.

11. --- As Canada becomes more fully industrialized it is increasingly important that fabrication of metal and mineral products be carried to successively later stages of preparation for ultimate utilization. It is not to be expected that all the fabrication will ever be done in Canada but emphasis must be placed on developing this kind of operation in Canada.

12. It is recommended that major emphasis should be given to supporting and expanding the Canadian scientific and technologic effort in a way that would encourage:

(a) <u>The development and utilization of new and sophisticated methods of locating mineral deposits.</u>

(b) <u>The search for ways to improve physical transportation methods and reduce transportation costs.</u>

(c) <u>The examination of problems associated with housing and other amenities in the "urbanization" of mining areas.</u>

(d) <u>The search for new methods of mineral processing.</u>

(e) <u>Extensive investigation of the technical and economic aspects of procedures, laws, taxation, etc. that would lead to a greater degree of fabrication, in Canada, of metals and minerals from Canadian sources.</u>

STRUCTURE OF INDUSTRIAL RESEARCH AND DEVELOPMENT

13. The value of the annual production of the mineral industry - metals, minerals and fuels - in Canada is well over

$4 billion. A high percentage of this production is exported, much of it in a raw or semi-processed state. While the real strength and primary source of income of the companies involved in mineral production are derived from ownership of the mineral deposits progressive groups are acutely aware of the need to keep abreast of or, indeed, to lead in the advancement of technology that will enable them to survive in a competitive world or to progress farther in the direction of fabricating finished products. Companies in the mineral industry thus have a deep interest in the national economic, social and science policies that may influence (a) their own ability and incentive to undertake research and development, or (b) the climate for the production of new ideas, the training of scientists and technologists, and for the translation of ideas through "innovation" to reality.

14. In considering the ability and incentive of industry to conduct research and development programmes it must be realized that a company does not, indeed cannot, carry out a research programme that is purely idealistic having no ultimate goal or purpose. Research management must be realistic in setting up, operating and, most of all, concluding a project. It is likely then that much the greatest proportion of industrial research is concerned with problems of short or medium range - only in exceptional circumstances can a company afford the luxury of "pure" research. Thus national policy, if it is to serve a useful purpose, must be such that the ad hoc or applied, or short term character of most industrial research is recognized and encouraged.

15. In the Canadian scene at the present time there are four Federal Government research incentive programmes:

(a) IRAP (Industrial Research Assistance Programme) administered by National Research Council.

(b) DIR (Directorate of Industrial Research) administered by Defence Research Board.

(c) IRDIA (Industrial Research and Development Incentives Act) administered by the Department of Industry, Trade and Commerce.

(d) PAIT (Programme for Advancement of Industrial Technology) administered by the Department of Industry, Trade and Commerce.

16. Without going into details (which are well known in industry and government) it may be said of these schemes that:

- IRAP and DIR, which are substantially identical, perform a useful service for some companies, they are relatively free of cumbersome restrictions but could be expanded and improved.

- IRDIA, this replaces a former tax concession with a grant. The view is held that only the 25% grant on capital expenditures offers a real incentive. The 25% grant on operating cost is subject to many restrictions such as: definition of research, a moving base and payment only for increase over the base, added administrative costs for the company, and limitation on exploitation. For a large company (and 80% to 90% of research is carried out by "large" companies) IRDIA offers little or no incentive. Its impact is, therefore, doubtful.

- PAIT is widely regarded as being of little use to industry. Administrative costs are too high, definitions too restrictive, financing repayments leads to an excessive rate of interest and, in general, the philosophy of "financing failure" cannot be sustained.

17. Another aspect of industrial research that concerns the mineral industry is the possibility of undertaking what might be termed "Industry Programmes" which would be the counterpart of "National Programmes" carried out by Government agencies. By "Industry Programme" is meant a study on a project quite specifically defined that would be carried out on a contract basis fully funded by Government, just as the National Programmes are fully funded. Such programmes could be medium or longer term but would be designed to provide information or expertise that

would eventually be useful in achieving national objectives. These should be comparable, in the mineral industry, with programmes already underway in the electronics - satellite communications area.

18. The industry is vitally concerned with ensuring that enough young people are trained in the areas of science and technology that are so important to its future growth. There is strong support for the view that there should be still closer association between industrial research departments that are active in studying ad hoc or applied projects and the university groups that are more inclined to undertake "discovery" research. It is thought that in this closer association both would benefit - the university people by a better knowledge of "real" problems and the industrial researchers by the infusion of young, new ideas. The suggestion has been made that a special incentive might be extended to companies by making all money spent for research in universities eligible for the 25% IRDIA grant, whether or not it represents an increase over a base year. Certainly a more effective dialogue between the universities and the mineral industry is much to be desired.

19. It is recommended that to enhance the value of industrial research in the field of mineral discovery, production, beneficiation and fabrication the following be considered:

(a) That in establishing policy for science and technology it be recognized that incentives, if they are to be useful, must take into account the inherent, practical, ad hoc, applied, down-to-earth character of the greatest majority of industrial research and development projects.

(b) That all the present Federal Government industrial research incentive schemes - IRAP, DIR, IRDIA, PAIT - be carefully and critically reviewed with the object of strengthening their impact on the mineral industry (and others!).

(c) The possibility be examined of introducing, in the mineral industry, "Industry Programmes" which would comprise full funding

on a contract basis of medium or long term type projects designed to provide information or expertise essential for broader "National Programmes".

(d) Devise procedures and incentives that would promote a more effective relationship between industry and the universities including, possibly, the designation of all industry expenditures in university research as being eligible for IRDIA 25% grants irrespective of base year considerations.

ADVISORY COMMITTEES

20. One of the most important functions the Canadian Institute of Mining and Metallurgy can perform in respect of Science Policy is to provide a forum where its members can be heard: a second, equally useful activity, is to establish channels of communication between its members and the centres of decision in Government. The "forum" is well-established over many decades but the "channels" are still obscure and not well defined.

21. In attempting to clarify the "channels" it is first necessary to understand that there are two aspects of policy - one is administration which has to do with the form of government organization, the compositions and functions of government science-based departments and agencies, of granting and other administrative bodies as well as with determining and acting upon day to day needs, research programmes, legislation and other similar matters. The second is advice which is concerned largely with future plans and projects but must also be available when current problems and proposals are being considered.

22. The two - administration and advice - come together at the level of decision - in the case of Federal Government this is at the level of the Cabinet and Cabinet Committees where, inevitably and quite properly, the decision must ultimately be politically-based. What is most important is that the decision-making body has available all the facts - scientific, technical,

social, economic, financial and political - upon which to exercise its judgement in reaching a decision. There are many sources of information but the Canadian Institute of Mining and Metallurgy, as a technical society, is primarily concerned with two - the Science Council of Canada and a proposed Advisory Committee on Science and Technology.

23. The Science Council of Canada should, as far as possible, be like the Economic Council - supported by government funds, but not provided with privileged information and thus completely free to study, to look into the future, to predict, to propose, to offer opinions, to chide, to "view with alarm", to recommend, to influence, to advise, but to have no part whatever in decisions. It can probably do these things more freely if there are no government officials on the Council, which would then comprise only people from the professions, industries, and universities. However, it would be most unfortunate if the opinions of leaders of government scientific and technical establishments were not obtained and their advice sought.

24. Consideration should be given to establishing an Advisory Committee on Science and Technology, which would comprise a group of about fifteen top-level people from the professions, private life, industry, and the universities who would be appointed by the Prime Minister to serve on a voluntary basis meeting about once a month. These people would be given privileged information and would be expected to give directly to the Cabinet, probably through its Chief Scientific Advisor, their collective views on the scientific and technical quality of projects and proposals brought forward by government departments, Science Council, public institutions and industry. The Canadian Institute of Mining and Metallurgy would expect that at least one, perhaps more than one, of the members of this Advisory Committee would be a member of the Institute. He would here express opinions as an individual <u>not</u> as a representative of the Institute.

25. It is recommended that the advisory structure for science and technology at Federal Government level be modified as follows:

(a) That the Science Council of Canada membership comprise only representatives of the professions, industry, the universities in Canada, but that advice and opinions of government officials be obtained of the Council. Hopefully, one or more members of the Council would be a member of the Canadian Institute of Mining and Metallurgy either *ex officio* or on a personal basis.

(b) That there be established an Advisory Committee on Science and Technology having access to privileged information and charged with advising the Cabinet on the scientific and technical aspects of projects and proposals submitted to it for consideration. Membership of fifteen or twenty would comprise professionals, industry, university, no government officials and, hopefully, one member of the Canadian Institute of Mining and Metallurgy selected on personal qualifications only.

The Canadian Institute of Mining and Metallurgy June 1969

APPENDIX A.

Notes on The Canadian Institute of Mining and Metallurgy

- - -

The Institute, since its Charter was granted in 1898, has counted among its members those who have made a significant contribution to the advancement of science and technology and to economic growth in the mineral industry in Canada. The Institute itself has contributed, as the Charter suggests, " .... by means of meetings for the reading and discussion of technical papers, and the subsequent distribution of such information as may be gained through the medium of publications.".

Membership in the Institute is in two categories, the principal qualification being:

Member - A person of established competence and integrity in the practice of engineering, geology, chemistry or other applied science in connection with the mining, metallurgical or petroleum industries or with (related) government, educational or research organizations.

Associate Member - A person of integrity without the technical training and experience required of a Member but who is interested, directly or indirectly, in the advancement of, or service to, the mining, metallurgical or petroleum industries.

The Institute is governed by a Council of 48 members who meet five times annually but who delegate certain authority to the Executive Committee of 7 members.

Operations of the Institute are conducted by a Secretariat, located at Institute Headquarters in Montreal, under the direction of the Executive Director.

The Institute has six geographic districts each headed by a Vice-President.

There are seven Technical Divisions:

Coal	Metallurgical Society of CIM
Geology	Metal Mining
Industrial Minerals	Petroleum Society of CIM
Mechanical-Electrical	

There are 48 Institute Branches in the major cities and mining areas across Canada from St. John's, Newfoundland, to Mayo, Yukon Territory.

Through a network of ad hoc and standing committees the Institute conducts studies, (as for example on Education for the Mineral Industry), effects liaison with U.S. and Commonwealth groups, commissions special volumes and publishes monthly the "Bulletin of the Canadian Institute of Mining and Metallurgy" and annually the "Transactions" of the Institute, also the "Canadian Journal of Petroleum Technology" and collaborates in the publication of "The Metallurgical Quarterly".

The Institute offers prizes for Student Essays, confers honours (such as medals and awards) on members and others who have made meritorious contributions, appoints 'Distinguished Lecturers', and participates, through its divisions and branches, in a wide variety of activities conducive to the welfare and growth of the mineral industry and to the advancement of the social and technical interests of the many thousands of people whose lives are affected by the industry and who, in turn, make it possible for the industry to thrive.

Membership in the Institute in April 1969, was:

Coal Division	209
Geology Division	1,805
Industrial Minerals Division	373
Mechanical-Electrical Division	433
The Metallurgical Society	1,124
Metal Mining Division	2,828
The Petroleum Society	747
TOTAL	7,519

The annual income of the Institute arising from membership dues, advertising, donations and other sources is about $350,000.

APPENDIX 203

BRIEF

to the

SENATE

SPECIAL COMMITTEE ON

SCIENCE POLICY

MÉMOIRE

au

COMITÉ SPÉCIAL

DU SÉNAT

SUR LA POLITIQUE SCIENTIFIQUE

Submitted by/Soumis par

CANADIAN HOME ECONOMICS ASSOCIATION

901 Burnside Building

151 Slater Street

Ottawa 4, Ontario

Confidential until date of hearing

Confidentiel jusqu'à date d'audition

INDEX

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SUMMARY

This brief considers the problems with regard to the formulation of a Science Policy, discusses our professional relationship to science, outlines research goals, and recommends increased emphasis on large multi-disciplinary mission-oriented research projects.

As one such project, we suggest the study of Family Life in an Urban Society.

INTRODUCTION

As policy decisions affect the economic, social and cultural development of our country for many years to come, the current investigation of the Senate Special Committee on Science Policy is of major importance. In an era of rapid change and technoligical growth, the establishment of goals, policies and priorities in any field can result in a more productive and economic use of both material and manpower resources. The rapidly advancing field of science will benefit as much, if not more than other areas, from close examination, considered forecasting, and policy making for the future.

THE CANADIAN HOME ECONOMICS ASSOCIATION

The Canadian Home Economics Association was organized in Winnipeg in 1939. During the intervening years it has grown steadily and in November 1954 it became an incorporated body.

The business of our professional association is administered by an elected Board of 26 Directors, with at least one director from each of the provinces. This Board of Directors includes an Executive Committee consisting of the President and eight members who carry out the administrative work of the Association during the year.

Other activities of the Association are carried on through committees among which are the following: Education, Family Life, Foods and Nutrition, Textiles and Clothing, and Professional Development. For details on the activities of these committees, please see Appendix.

Since 1948, the Canadian Home Economics Association has been affiliated with the International Federation of Home Economics and an interested participant in its activities. For more than half the time since our affiliation, members of our association have served, one at a time as elected members of the Executive of this international body.

This brief has been prepared by the Executive Committee of the Canadian Home Economics Association in consultation with Deans of Faculties of Home Economics (or related faculties) at universities in Canada. (Appendix page).

SCIENCE ORIENTATION OF THE PROFESSION

University courses in Home Economics are based heavily on science, including study in physical science, applied science and the social sciences. To illustrate, the following is a summary of the science aspects of undergraduate programs at Canadian universities:

Physical Sciences - Chemistry, Physics, Biology, Mathematics, Physiology, Organic Chemistry, Biochemistry, Microbiology, Histology.

Applied Science - Food Chemistry, Experimental Foods, Quantitative Food Analysis, Nutrition, Textile Chemistry, Family and Community Studies, Family Dwellings, Management of Resources in the Home, Consumer Economics, Computer Programming, Polymer Chemistry.

Social Science - Psychology (including separate courses in Child, Adolescent, Educational and Industrial Psychology), Sociology (in addition to a general course, specific courses in Family and Community Sociology), Economics, Philosophy, and Statistics.

It would be difficult to give the percentage of time spent studying each of the above areas due to fluctuations from university to university and variations that result from specialization in the second, third and fourth years. At a conservative estimate, study in the above areas would represent approximately 75% of total university program in Home Economics.

FORMULATION OF A SCIENCE POLICY

Any establishment of policy should be formed within a framwork that includes goals, assessment of resources, consideration of various components and allocation of intensity of interest. It should be fluid enough to adjust to change in the development of our country. Realizing this, one readily appreciates the monumental dimensions of the task facing the Senate Special Committee.

As an association, with limited investigative facilties of our own, we offer suggestions for consideration, but do not wish to infer exclusion of other important topics. Thus, we confine our proposals to those areas of direct concern to our professional association without the intention of implying lesser importance to other areas.

GOALS

There is a tendency to outline goals for a Science Policy, as a starting point. In our view, overall goals for society should first be clarified and then the Science Policy, Economic Policy, Welfare Policy, Foreign Policy, Education Policy and so on, should dovetail into these objectives for the ideal society.

With this broader base, it would then be anticipated that goals for a Science Policy would include the following aims:

1. Economic goals for family stability
   - full employment
   - adequate housing
   - social security
   - sufficient purchasing power for basic needs of food, clothing and shelter and additional funds for selected amenities.

2. Educational goals that offer:
   - advanced study for all who demonstrate ability and interest
   - adult education programs for developing broader interests, upgrading individuals, and keeping pace with advances in specific fields
   - programs for the enrichment of family life through study of the evolving patterns of families in this era of dynamic social change

3. Health goals to ensure
   - physical and mental well-being accompanied by high life expectancy
   - high standards of medical care
   - adequate knowledge of preventative measures that contribute to good health

4. Social goals
   - to ensure the right of the individual to develop to his full potential as a human being
   - to develop happy family relationships as a sound basis for promoting harmonious national and international relations

5. Cultural goals

- to encourage an appreciation of Canada's two principal cultures
- to broaden knowledge of, and to develop the arts and customs of Canada.

ASSESSMENT OF RESOURCES

Studies by the Science Secretariat and the Science Council of Canada should prove useful in assessing the quantity and quality of manpower necessary for implementing the major scientific programs which are recommended as a result of the formulation of a Science Policy. This would be true of the detailed studies by discipline of the manpower now in training, that are currently in the organizational stages by the Science Council.

As a profession embracing several disciplines and concerned with the implementation of research, both basic and applied, for the benefit of individuals and society, Home Economics anticipates a greater role in the future. Consequently, our association is expanding efforts in the area of career guidance and re-education.

In this brief we will be recommending one broad scientific program that will benefit the majority of Canadians,and in ever increasing numbers as the trend to urban living continues. It is difficult to assess the financial resources necessary to implement the recommendation as it would need to be defined in detail and estimates obtained for each area of study. However, the benefits of the program would advance our country materially toward the goals of the ideal society and thus would undoubtedly merit the investment.

RESEARCH,DEVELOPMENT AND INNOVATION

Throughout this report, we have utilized the terms Basic Research, Applied Research, Development and Innovation as defined by the Science Council of Canada in Report No. 4 "Towards a National Science Policy for Canada," well recognizing that there is no sharp line of demarcation separating the activities so described.

To benefit fully from expenditures in Research and Development, it is recognized that the project must be carried through to innovation which depends on industry participation and, in the area of social sciences, implementation by all levels of government and welfare agencies.

MISSION - ORIENTED RESEARCH

The organizing of research into large, multi-disciplinary projects to fulfill a basic need or solve a specific problem has many advantages and we list but a few:

- a built-in incentive to carry the discoveries through the innovation process
- improved communication among the participating research groups and application of the results in a variety of disciplines
- more emphasis on applied research
- the size of the project would mean a generally greater awareness of the research program should result in a keener interest by industry
- a greater tendency to tailor research to the specific needs of the country
- such research would be linked more closely to the basic goals of a Science Policy.

PROPOSED MAJOR RESEARCH PROJECT

We propose as a major research project - The Study of Family Life in an Urban Society.

Analysing the proposal, one can quickly see the division into:

- study of urban living with its inherant problems of housing, transportation, pollution, land use, poverty, social disturbance, employment, urban renewal, educational and recreational facilities.
- study of the effect on the family with the ever increasing problems in today's society of marriage instability, health, youth unrest, use of drugs, crime, financial problems of credit buying, unwise spending, plus study of the changing cultural and moral patterns for better forecasting of trends.

The very urgency of the pressures requiring such a study should ensure the application of the results in those areas where concrete proposals can be formulated. Further, the magnitude of the study would involve researchers in many disciplines, chiefly in the applied science and social science areas.

This project would fulfill many of the basic requirements for research activity in Canada in that:

- it seeks a solution to a major national problem that is of social and economic significance
- it would not benefit greatly by research conducted in other countries
- it is directed toward a long-term need of society
- its magnitude makes it imperative that it be initiated by the federal government
- the broad scope lends itself to multiplicity of sources for financing the project.

INTEREST OF OUR ASSOCIATION IN RESEARCH

Members of the Canadian Home Economics Association are employed in a wide range of positions, some as nutritionists, teachers, dietitians, home management specialists, extension specialists, and are employed in educational institutions, hospitals, industry, social welfare agencies and in communications field.

We are most interested in encouraging applied research concerned with human beings in relation to environmental factors such as food, clothing, housing and human relationships.

Our awareness of the need for graduate study in Home Economics prompted the establishment of a Scholarship Fund by the Association. As soon as this fund exceeds $50,000, awards to graduate students will commence. At the present time more than $30,000 has been subscribed and our aim is to have sufficient funds by 1970.

Methods of project selection and evaluation have only been outlined at this time but undoubtedly there will be a direct relationship between our research support and the main objective of our association which is

"To promote the welfare of the Canadian home and to serve the community life of Canada."

CONCLUSION

We urge that serious consideration be given to large multidisciplinary, mission-oriented research projects in the formulation of a Science Policy for Canada. As one such project we suggest the study of Family Life in an Urban Society.

APPENDIX

CANADIAN HOME ECONOMICS ASSOCIATION

OFFICERS FOR THE 1968-69 TERM OF OFFICE

Past President:
Miss Wanda Young,
College of Home Economics,
University of Saskatchewan,
SASKATOON, Sask.

President:
Miss Sally Henry,
Maple Leaf Mills Limited,
43 Junction Road,
Toronto 9, Ontario.

President Elect:
Mrs. Bruce Cochran,
912 Spring Garden Terrace,
Halifax, N.S.

Vice President:
Miss Audrey Warner,
808 - 50 Prince Arthur Ave.,
Toronto 5, Ontario.

Secretary:
Miss Mary Broadley,
308 - 810 Royal York Road,
Toronto 18, Ontario.

Treasurer:
Mrs. D.B. Rankin,
16 - 129 Woodridge Cres.,
Ottawa 14, Ontario.

CLASS "A" DIRECTORS
Term of Office Expires 1970

British Columbia:
Mrs. Arthur E. Taylor,
2268 Kensington Ave.,
Burnaby 2, B.C.

Alberta:
Mrs. D.E. MacDougall,
331 - 46th Ave. S.W.
Calgary 6, Alberta.

Ontario:
Miss Grace Porterfield,
396 Queens Ave.,
London, Ontario.

Nova Scotia:
Mrs. Jean M. Peck,
P.O. Box 80,
Wolfville, N.S.

Prince Edward Island:
Miss Irene Mountain,
303 Central St.,
Summerside, P.E.I.

CLASS "B" DIRECTORS
Term of Office Expires 1969

Saskatchewan:
Mrs. Donna Schreffler,
35 Richmond Crescent,
Saskatoon, Sask.

Manitoba:
Mrs. G. Szeker,
Manitoba Department Agriculture,
Norquay Building,
Winnipeg 1, Manitoba.

Québec:
Miss Kathleen Kinnear,
365 Maple Ave.,
St. Lambert, P.Q.

New Brunswick:
Mrs. Frances Wilce,
207 Bessborough St.,
Fredericton, N.B.

Newfoundland:
Mrs. Gordon MacDonald,
8 Rostellan Place,
St. John's, Newfoundland.

CHAIRMEN OF COMMITTEES

College Clubs:
Miss Elizabeth Turnbull,
School of Household Economics,
University of Alberta,
Edmonton, Alberta.

CHAIRMEN OF COMMITTEES

Education:
Miss Charlotte Black,
407 West 44th Ave.,
VANCOUVER 15, B.C.

C.H.E.A. Officers 1968-69

Extension:
Mrs. Vera Macdonald,
6023 - 111th Ave.,
Edmonton, Alberta.

Family Life:
Mrs. W.A. Seaman,
24 College St.,
Sackville, N.B.

Foods and Nutrition:
Dr. Shirley M. Weber,
School of Home Economics,
University of Manitoba,
Winnipeg 19, Manitoba.

Public Relations:
Miss Wendy Sanford,
Corning Glass Works of Canada Ltd.,
135 Vanderhoof Ave.,
Toronto 17, Ontario.

Awards Selection:
Past President.

H.E.I.B. Section:
Mrs. Kay Hodgins,
F.H. Hayhurst Co. Ltd.,
55 Eglinton Ave. E.
Toronto 12, Ontario.

Journal:
Miss Margaret C. Smith,
102 Airdrie Road,
Toronto 17, Ontario.

Membership:
Miss Joyce Mayo,
114 Wentworth St.,
Saint John, N.B.

Textiles and Clothing:
Miss Jean McLarty,
3520 Enniskillen Circle,
Box 143,
Cooksville, Ontario.

SPECIAL COMMITTEE CHAIRMEN

Archives:
Miss Edna W. Park,
136 South Drive,
Toronto 5, Ontario.

Career Guidance:
Mrs. Elaine Adam,
4507 Sherwood Drive,
REGINA, Sask.

Convention 1970:
Miss Carol Taylor,
503 - 265 Balliol St.,
Toronto 7, Ontario.

"Fellow":
Mrs. A. Wenhardt,
29 Kirk Crescent,
Saskatoon, Sask.

Nominating:
Miss Louise Calder,
Supervisor of Home Economics,
Department of Education,
Halifax, N.S.

Salary Survey:
Mrs. Cecile Bexton,
General Foods Kitchens,
2200 Yonge St.,
Toronto, Ontario.

Scholarship Fund - Comptroller:
Miss Ruth E. Berry,
School of Home Economics,
University of Manitoba,
Winnipeg 19, Manitoba.

Scholarship Drive to Industry:
Mrs. D.I. MacKinnon,
240 Bleeker Ave.,
Belleville, Ontario.

Deans of Faculties of Home Economics or related faculties

Miss Doris M. Anderson,
Prince of Wales College,
CHARLOTTETOWN, P.E.I.

Miss Elizabeth MacMillan,
Dean, School of Home Economics,
Acadia University,
WOLFVILLE, Nova Scotia.

Sister Catherine MacNeill,
Dean, Faculty of Home Economics.
Mount St. Bernard College,
St. Francis Xavier University,
ANTIGONISH, Nova Scotia.

Miss Mary Morley,
Director, School of Home Economics,
Mt. St. Vincent University,
HALIFAX, Nova Scotia.

Miss Marjorie Kennish,
Director,
Massey Treble School of
Home Economics,
Mount Allison University,
SACKVILLE, New Brunswick.

Soeur Ghislaine Cormier,
Directrice,
Ecole des Sciences Domestiques,
Université de Moncton,
MONCTON, Nouveau-Brunswick.

Soeur Françoise Saint-Hilaire,
Directrice,
Département de diététique,
Faculté d'Agriculture,
L'Université Laval,
Ste. Foy - Québec 10, Québec.

Mlle. Claire Dalmé, M.N.S.,
Directrice intérimaire,
Institute de diététique et de
nutrition,
Université de Montréal,
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Miss Helen R. Neilson,
Director,
School of Food Science,
Macdonald College,
STE. ANNE DE BELLEVUE, Québec.

Sister Isabel Chisholm, C.N.D.
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Sister Solange Lemay,
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University of Ottawa,
OTTAWA 2, Ontario.

Dr. Barbara McLaren,
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Sister Dominica,
Head-Department of Home Economics,
Brescia College,
University of Western Ontario,
LONDON, Ontario.

Dr. Janet M. Wardlaw,
Macdonald Institute,
University of Guelph,
GUELPH, Ontario.

Dr. L.E. Lloyd,
Director,
School of Home Economics,
University of Manitoba,
WINNIPEG, Manitoba.

Dr. Edith Rowles Simpson,
Dean-College of Home Economics,
University of Alberta,
EDMONTON, Alberta.

Dr. Melvin Lee,
Director-School of Home Economics,
University of British Columbia,
VANCOUVER, B.C.

PERCENTAGE BREAKDOWN BY CATEGORY OF C.H.E.A. MEMBERSHIP

Teachers	35.6%
Supervisors	1.8%
University	7.4%
Homemakers	11.1%
Business	10.0%
Extension	6.1%
Dietitians	5.5%
Government	4.5%
Nutritionists	2.5%
Retired	5.5%
Other	4.1%
Graduate students	0.9%
Graduating students	5.0%
	100.0%

DEFINITIONS

Home Economics - is the area of study that correlates the sciences and humanities concerned with food, clothing, shelter and human relations and their effective application in the family, community and world.

Home Economist - is one who holds a university degree in Home Economics and applies this professional knowledge in the field of education, dietetics, nutrition, family living, business communications or research.

Basic or Fundamental Research - which is generalized search for new knowledge without specific application in mind, and which is one of man's crowning cultural achievements. Any piece of basic research is judges on the contributions which it makes to the conceptual development of science.

Applied Research - is the search for new knowledge to provide a solution to a specific problem which is defined at the outset of the research program. It does not differ radically from basic research in methods or scope, but in motivation. Applied research programs must be judged by their relevance to the pre-selected objective.

Development - is really a final stage of applied research which is most clearly seen in the evolution of new goods or services. It is a costly activity in as much as the building of prototypes, the construction of pilot-plants or the conduct of full-scale trials are costly undertakings.

Innovation - is the practical implementation of the results of research and development to provide new or improved goods or services. Innovation is often a capital-intensive activity since new production facilties are often required. In deciding to undertake programs of development and innovation, the expenditures forseen must be weighed against the probability of achieving economic gain or social benefit.

THE CANADIAN HOME ECONOMICS ASSOCIATION

CONSTITUTION AND BY-LAWS

- was incorporated in 1954 under the provisions of the Companies Act, Part II, by Letters Patent as a Corporation for the purpose of carrying out, in more than one province of Canada, the following objectives:

a) To promote the welfare of the Canadian home and to serve the community life of Canada.

b) To develop standards within the field of Home Economics.

c) To bring about a closer co-operation among Home Economists in the different fields of Home Economics.

d) To co-ordinate the aims and objectives of all local and provincial Home Economics associations.

e) To encourage and aid investigations, research and surveys, and to make available reports, pamphlets and other publications relating to Home Economics.

f) To further co-operation between the Association and other Canadian associations interested in the welfare of the Canadian Home.

- The association shall be carried on without pecuniary gain to its members and any profits or other accretions to the association shall be used in promoting its objectives.

<u>By-law I</u> CORPORATE SEAL

The seal of the Association shall have the words "Canadian Home Economics Association" endorsed thereon.

<u>By-law II</u> MEMBERSHIP, CLASSES

There are three classes of membership: active including life, associate and honorary.

<u>By-law III</u> ACTIVE MEMBERS

1. Active membership shall be limited to individuals with the following qualifications whose application is approved by the Board of Directors:

   a) a degree in Home Economics from a recognized university, or
   b) a degree from a recognized university with a major in a related field and, in addition, provides evidence satisfactory to the Board of Directors that through approved training or experience, the person has become, in interest and practice, a Home Economist, or
   c) was a member in good standing of the unincorporated body known as the Canadian Home Economics Association at the time of the incorporation of the Association and who maintains continuous membership in good standing of this Association.

2. An individual who has been an active member for at least three years may become a life member subject to the approval of the Board of Directors.

3. An active member, in recognition of outstanding contribution to the Association over a period of years, may be awarded a special honorary life membership, subject to the approval of the Board of Directors.

By-law IV ASSOCIATE MEMBERS

Associate membership shall be limited to individuals with the following qualifications whose application is approved by the Board of Directors:

A secondary school certificate and:

a) a Home Economics diploma granted by a recognized college or School of Technology after two years of successful study, or
b) a provincial Home Economics teacher's certificate, or
c) a provincial teacher's certificate with additional training in home economic s equivalent to at least one year of successful study.

By-law V HONORARY MEMBERS

Honorary membership is granted by unanimous vote of the Board of Directors to a non-member who has rendered exceptional service to the field of Home Economics.

By-law VI RIGHTS OF MEMBERS

a) Active members in good standing shall be entitled to attend and vote at meetings of the Association and to hold appointive or elective office.

b) Associate members in good standing shall be entitled to attend and vote at all meetings of the Association but shall not be eligible for elective or appointive office.

c) Honorary members shall have no voting privileges nor be eligible for any elective or appointive office.

By-law VII RESIGNATION AND RE-INSTATEMENT

Any member may withdraw from the Association by sending a written resignation to the secretary. Members who have resigned in good standing may rejoin the Association by notification and payment of the current fee (except By-law III, section 1c)).

Any member whose dues are delinquent for one year shall forfeit membership. To be re-admitted to the Association, such member shall submit a new application.

By-law VIII SUSPENSION OR EXPULSION

On recommendation of the Board of Directors, any member may be required to resign by a vote of three-quarters of the members at an annual meeting.

By-law IX HEAD OFFICE

The head office of the Association shall be located at the City of Ottawa in the County of Carleton and Province of Ontario, Canada, and the place or places therein where the business of the Association may from time to time be carried on.

The Association may establish such other offices and agencies elsewhere within Canada as the Board of Directors may deem expedient by resolution.

By-law X BOARD OF DIRECTORS

a) The property and business of the Association shall be managed by a Board of 26 Directors. The Directors shall include the officers of the Association and there shall be at least one Director residing in each Province of Canada. The immediate Past President of the Association shall be a Director ex officio during the two years following her term of office as President.

b) The Board of Directors, other than the officers, shall be divided into two classes to be known respectively as classes "A" and "B" which classes shall be composed of 10 directors each.
At each annual general meeting one class of directors shall retire: in even years, e.g. 1966, 1968 etc., class A directors shall be retired and others elected; in odd years, e.g. 1967, 1969 etc., class B directors shall be retired and others elected, in accordance with the pattern established at the first annual meeting when the classes of directors replaced the provisional directors named in the Letters Patent.

c) The directors shall have power to authorize expenditures on behalf of the Association and may delegate by resolution to an officer or officers of the Association the right to employ and pay salaries to employees. The directors shall have the power to make expenditures for the purpose of furthering the objects of the Association.

d) The directors may exercise all such powers of the Association as are not by the Companies Act, or by these by-laws required to be exercised by the members at general meetings.

By-law XI TERM OF OFFICE OF BOARD OF DIRECTORS

a) Directors shall be appointed for a term of two years. They shall be eligible for reappointment for a further term of two years. They shall not be eligible for re-election to the Board of Directors after completing two consecutive terms of office until such director has had one clear year out of office as director, but this provision shall not apply to directors ex officio. Directors ex officio, however, cannot hold the same office for longer than two consecutive terms.

b) Retiring directors shall continue in office until the dissolution or adjournment of the meeting at which their successors are elected.

By-law XII VACANCY IN THE BOARD OF DIRECTORS

Any vacancy occurring in the Board of Directors may be filled for the remainder of the term by the directors among the qualified members of the Association, otherwise such vacancy shall be filled at the next annual meeting of members.

Any director elected or appointed to fill such vacancy shall hold office for the unexpired portion of the term of the director whom she is replacing.

The office of director shall be automatically vacated:

a) If a director shall resign her office by delivering a written resignation to the Secretary of the Association.

b) If she is found to be of unsound mind.

c) If she becomes bankrupt or suspends payment or compounds with her creditors.

d) If at a special general meeting of members a resolution is passed by three-quarters of the members at the meeting that she be removed from office.

By-law XIII EXECUTIVE COMMITTEE

The Board of Directors shall at their meeting held immediately after the annual general meeting of members and from time to time as vacancies occur, appoint at least four and not more than eight of their body as an executive committee of which the President shall also be a member and the following provisions shall apply thereto:

a) The President shall ex officio be Chairman of the Executive committee and in her absence the vice-President shall be Chairman. In the absence of the President and the vice-President, the committee shall choose one of its body to be Chairman. The Chairman shall preside at all meetings and shall have a casting vote in case of a tie.

b) In the event of there being no quorum present at any meeting of the executive committee any director or directors of the Association who is or are requested by the Chairman of the meeting to attend such meeting shall have the right to attend and shall thereupon be a member or members of the executive committee for such meeting.

c) During the intervals between the meetings of the Board of Directors, the executive committee shall possess and may exercise (subject to any regulations which the directors may from time to time impose) all the powers of the Board of Directors in the management and direction of the operations of the Association (save and except only such acts as must by law be performed by the directors themselves) in such manner as the executive committee shall deem best for the interest of the Association

in all cases in which specific directions shall not have been given by the Board of Directors.

d) All action by the executive committee shall be reported to the Board of Directors at its meeting next succeeding such action and shall be subject to revision or alteration by the Board of Directors; provided that no acts or rights of third parties shall be affected or invalidated by any such revision or alteration.

By-law XIV OFFICERS

Organization

a) The officers of the Association shall be a President, a President-elect, a vice-President, a Secretary and a Treasurer, each of whom shall be a director ex officio. There may be such other officers as the Board of Directors may by by-law determine.

b) The President, the President-elect, the vice-President, the Secretary and the Treasurer and other officers (if any) shall be elected at an annual meeting of members and shall hold office for two years and until their successors are elected or appointed in their stead.

c) There may also be an honorary office of Patron. The Patron shall be appointed at each annual meeting of members.

By-law XV DUTIES OF OFFICERS

President

The President shall be the chief executive officer of the Association. She shall preside at all meetings of the Association and of the Board of Directors. She shall have the general and active management of the business of the Association. She shall see that all orders and resolutions of the Board are carried into effect and she or a vice-President with the Secretary or other officer appointed by the Board for the purpose shall sign all by-laws and other documents requiring the signatures of the officers of the Association.

President-elect

The President-elect shall become acquainted with the duties of the President and the general activities of the Association.

Vice-President

The Vice-President shall, in the absence or disability of the President, perform the duties and exercise the powers of the President and shall perform such other duties as shall be imposed upon her by the Board.

Treasurer

The Treasurer shall have the custody of the corporate funds and securities and shall keep full and accurate accounts of receipts and disbursements in books belonging to the Association and shall deposit all monies and other valuable effects in the name and to the credit of the Association and in such depositories as may be designated by the Board of Directors. She shall disburse the funds of the Association as may be ordered by the Board, taking proper vouchers for the disbursements, and shall render to the President and Directors at the regular meeting of the Board, or whenever they may require it, an account of all her transactions as Treasurer and of the financial position of the Association. She shall also perform such other duties as may be determined by the Board.

Secretary

The Secretary shall attend all sessions of the Board and all meetings of the members and act as clerk thereof and record all votes and minutes of all proceedings in the books to be kept for that purpose. She shall give or cause to be given notice of all meetings of the members and of the Board of Directors, and shall perform such other duties as may be prescribed by the

Board of Directors or President, under whose supervision she shall be. She shall be custodian of the seal of the Association which she shall deliver only when authorized by a resolution of the Board to do so and to such person or persons as may be named in the resolution.

By-laws XVI NOMINATING COMMITTEE

a) A nominating committee shall be appointed annually by the Board of Directors.

b) The nominating committee shall receive nominations for the offices of President-elect, Vice-President, Secretary, Treasurer and Directors and shall prepare a slate of candidates whose willingness to act has been obtained in writing. A list of such candidates shall be sent to each member with the notice of each annual general meeting.

c) Further nominations may be made providing the name of each nominee, signed by ten active members in good standing, is deposited with the Secretary at least 15 days prior to the annual meeting along with evidence of consent of each nominee.

By-law XVII MEETINGS

1. Board of Directors

Meetings of the Board of Directors may be held at any time and place to be determined by the Directors provided that 10 days' notice of such meeting shall be sent in writing to each Director. No formal notice shall be necessary if all Directors are present at the meeting or waive notice thereof in writing.

In the event a Director of the Canadian Home Economics Association is unable to attend a meeting of the Board of Directors, she may propose a representative possessing the following qualifications for the approval of the Executive Committee:

A. Director's Representative:

a) shall be a member classed as an "Active Member" (see By-law III).
b) shall have been a member in good standing for three or more years in the Canadian Home Economics Association.
c) shall reside in the same Canadian province as the Director she is representing or shall be a member of the Committee of which the Director is Chairman.
d) shall be entitled to one vote.
e) shall not be included in the number of Directors required to form a quorum.

2. Executive Committee

The executive committee shall meet at such times and places as they shall by resolution appoint, and shall also meet at any other time or place at the call of the President to be given orally or by telephone or in any of the manners provided in the by-laws of the Association respecting notice to Directors.

3. Members

a) The annual meeting of the members of the Association shall be held at the head office of the Association or elsewhere in Canada and on such date and at such time as the Board of Directors may designate. At such meeting, the members shall elect officers and Directors and shall receive a report of the Directors.

b) Thirty days' prior written notice shall be given to each member of any annual or special general meeting of members. Each active and associate member present at a meeting shall have the right to excercise one vote.

c) A member may appoint as her proxy any other member to vote at any annual or special general meeting. The proxy shall be in any common form or as required by the Directors.

d) At all meetings of members of the Association every question shall be determined by a majority of votes unless otherwise specifically provided by the Companies Act or by these by-laws.

By-law XVIII QUORUM

a) Board of Directors: 10 (not including a Director's representative).
b) Executive Committee: 3
c) Annual or special general meeting: 20

By-law XIX FINANCE

Fiscal year: The fiscal year of the Association shall end on the 30th day of April each year.

1. Fees

a) Annual dues shall become payable the 1st day of May each year and shall be deemed to be in arrears the 1st day of August next following.

b) Active and associate members shall pay an annual fee as determined by the Board of Directors and approved at an annual general meeting.

c) Life members shall pay a single fee as shall be determined by the Board of Directors and approved at an annual general meeting.

d) Home Economics graduates from Canadian Universities for the year immediately following graduation may become members of the Association at a fee which is one-half the current membership fee.

e) Honorary members shall not pay any fees.

2. Trust Fund: A trust fund shall be established from life membership fees and such other funds as may become available. Its purpose shall be designated by resolution of the Board of Directors and the income of said fund shall be used at the discretion of the Board of Directors.

3. Scholarship Fund:

a) The permanent scholarship fund shall be for the purpose of awarding scholarships for graduate work in matters relating to the objectives of home economics. All monies collected for this purpose are to be deposited with a Trust company "in perpetuity" and the interest shall be used either to increase the capital investment, or when large enough, to award scholarships.

b) The Scholarship Fund committee shall consist of the President, Vice-President, Secretary and the Comptroller of the Scholarship Fund, such committee to be designated as the "Charitable Organization" required by the Department of National Revenue in connection with the exemption of donations for income tax purposes.

c) The Comptroller of the Scholarship Fund shall be appointed by the Executive for a period of five years, which may be followed by re-appointment for a further period of five years. The Comptroller shall be responsible for receiving all contributions, making bank deposits, transferring of funds to the investors and issuing official receipts.

4. Auditor: The members shall at each annual meeting appoint an auditor to audit the accounts of the Association and to hold office until the next annual meeting,provided that the Directors may fill any vacancy in the office of Auditor. The remuneration of the Auditor shall be approved by the Board of Directors.

5. Remuneration of Directors, Officers, Agents and Employees

a) Directors, Director's representatives and active members appointed to represent the Association, may by resolution of the Board receive remuneration and/or reasonable expenses for their attendance at meeting of the Board and while travelling in connection with the business of the Association.

b) The remuneration of agents and employees shall be fixed by the Board of Directors by resolution. Such resolution shall have force and effect only until the next annual or special general meeting of members when it shall be confirmed by resolution of the members, and in the absence of such confirmation by the members, then the remuneration to such agents or employees shall cease to be payable from the date of such meeting of members.

By-law XX AMENDMENT OF BY-LAWS

The by-laws of the Association may be repealed or amended by by-laws enacted by a majority of the Directors at a meeting of the Board of Directors and sanctioned by an affirmative vote of at least two-thirds of the members at a meeting duly called for the purpose of considering the said by-law, provided that 30 days' prior written notice has been given to each member and that the enactment, repeal or amendment of such by-law shall not be enforced or acted upon until the approval of the Secretary of State has been obtained.

By-law XXI AFFILIATION

The Board of Directors may prescribe such rules and regulations not inconsistent with these by-laws providing for the affiliation with the Association of college Home Economics clubs and regional Home Economics associations upon such conditions and on the payment of such fees as they deem expedient.

By-law XXII SIGNING OF CHEQUES AND CERTIFICATION OF DOCUMENTS

a) All cheques, bills of exchange, promissory notes or any other negotiable instruments shall be signed by any two of three signing officers as appointed by the Board of Directors.

b) Contracts, documents or any instruments in writing requiring the signature of the Association shall be signed by the President and any one of the Vice-President, the Secretary or the Treasurer or a Director; or by such other officers or directors as may be by the Directors prescribed by resolution. All contracts, documents and instruments in writing so signed shall be binding upon the Association without any further authorisation or formality.

c) The Directors shall have power by resolution to appoint an officer or officers on behalf of the Association either to sign contracts, documents and instruments in writing generally or to sign specific contracts, documents and instruments in writing.

d) The seal of the Association when required may be affixed to contracts, documents and instruments in writing signed as aforesaid by any officer or officers appointed by resolution of the Board of Directors.

By-law XXIII RULES AND REGULATIONS

The Board of Directors may prescribe such rules and regulations not inconsistent with these by-laws relating to the management and operation of the Association as they deem expedient, provided that such rules and regulations shall have force and effect only until the next annual meeting of the members of the Association when they shall be confirmed, and in default of confirmation at each annual meeting of members shall at and from that time cease to have force and effect.

In these by-laws the singular shall include the plural and the plural the singular; the feminine shall include the masculine.

CANADIAN HOME ECONOMICS ASSOCIATION

Committee Activities

EDUCATION

This committee has been active since the inception of the Association. Its studies have included:

Home Economics education at the High School and University levels
Suggested requirements for undergraduate training for Home Economics teachers and extension service workers
Visual aids for teaching Home Economics (1950)
Book reviews for the Journal 1950 - 1955
Investigation of opportunities of interest to Home Economics students and teachers, i.e., scholarships, summer courses, travel tours, etc.
Investigation of the problem of certification of teachers
Proposal for the establishment of an Awards Committee at national level to work out ways and means for national awards, tenable at any university willing to co-operate in a post-graduate program for Home Economics
Setting up of an evaluation committee for membership in C.H.E.A.
In 1964 began compiling a tabled report on "An Estimate of the Number of Home Economists Employed in Canada" and "The Number of Students Registered in Degree Courses in Home Economics in Canadian Universities". These reports are published in the C.H.E.A. Journal each spring.
In 1965 a new career folder for C.H.E.A. was prepared and approved for publication
New Terms of Reference were approved in 1965.
In 1967 published a list of "Magazines, Pamphlets and Illustrative Material, Senior High School Home Economics Courses".
In 1968 presented a brief on the Status of Women.

FAMILY LIFE

In 1954, the Homemakers' Committee and the Committee on Child Development were combined into a Committee on Family Life. Emphasis was then given to ways and means of encouraging Family-centered teaching. A brief reading list has been prepared. See report of the Family Life Committee, C.H.E. Journal, June 1955.

Previous projects included studies of household appliances desired by homemakers, the part which homemakers who are home economics graduates play in community affairs, the need for standardization in the clothing field.

In 1956 a survey of university home economics curricula as to courses of importance in family life was completed. Copies were sent to persons concerned with home economics education and to heads of university departments.

During the latter part of 1960 the committee worked together on the development of a report on "Women and Family in a Changing World". This report became part of the Canadian brief on this topic presented at the International Council of Women Meeting in Istanbul in September. A copy of this report is published in the Annual Reports, July 1960.

In 1964 the Family Life Committee prepared the booklet "The Employed Mother" for the Canadian Conference on the Family. A representative attended the conference at Rideau Hall.

Two representatives attended the Canadian Conference on Children held in November 1965 in Montreal.

In 1967 the Family Life chairman attended the International Conference on the Family held in Quebec.

A questionnaire was formulated for ciculation amongst Schools of Social Work, Family Welfare associations and Public Welfare Agencies.

FOODS AND NUTRITION

This has always been an active committee, keeping in touch with the Canadian Council on Nutrition and the Nutrition Division of the Department of National Health and Welfare.

During the war years, the members co-operated in dietary and food surveys.

Studies have been made of nutrition in the curricula of elementary schools and in teacher-training institutions.

1950 - A survey was undertaken to determine where and how nutrition education entered into the school curricula of the nine Canadian provinces and Newfoundland.

1952 - A study was made of what nutrition was being taught, how it was being taught and how effectively, in the various teacher-training institutions throughout Canada in health and home economics.

1954 - Terms of Reference of the Nutrition Committee were formulated. A study was made of the nutrition content of the course for social workers at the University of British Columbia.

1955-56 A joint project with the Nutrition Committee of the C.D.A. was carried out and its subject was "Food Misinformation in Canada".

1957-58 Publication of the above report in the December 1957 issue of the C.H.E. Journal.

1960-62 Preparation of the Brief to the Royal Commission on Health Services. Abstracts of current nutrition articles and general articles on nutrition were prepared for the Journal.

1962-64 The name of the Nutrition Committee was changed to Foods and Nutrition Committee. A Brief was prepared for presentation to the Senate Committee on Aging.

1966 - C.H.E.A. was invited to particpate in the Canadian Conference on Aging held in January and two representatives attended.

1966-68 The chairman of this committee was also chairman of the Canadian Dietetic Association Committee on Nutrition, and a member of the Prairie Provinces Cost Study Commission.

TEXTILES

This committee has been primarily interested in (1) opportunities for employment of home economists in the textile industry, (2) better labelling, and (3) promotion of the use of Canadian-made textiles.

A study of illustrative material available for the use of teachers and extension service workers was made in 1955, 1959, 1962.

In 1957 a textile chart entitled "Fibre and Fabric Facts" was made, with arrangements for printing and general distribution completed through the kind co-operation of the Canadian Fabric Foundation. It was distributed to C.H.E.A. members in leaflet form in the December 1957 Journal. The project was carried out by this committee with Mrs. Martha Milne, Quebec representative on Textile committee, assisting with the compilation. This leaflet was revised in 1967.

During 1961-62 the committee investigated the current labelling laws regarding textiles and clothing with a view to undertaking a project to promote more adequate labelling. Close co-ordination is maintained with the committee of the Canadian Associaton of Consumers on informative labelling and standardized sizing of consumer garments.

In 1962 the university teachers of Clothing and Textiles held a one-day curriculum workshop in Ottawa before the C.H.E.A. convention.

PROFESSIONAL PROGRESS

This committee formed in 1959 had as its objective to look critically at the development in the field of home economics since its birth, survey its progress in the interval, assess our present value as a profession in today's society, and project a course for the profession in the future.

The committee began this tremendous task by:

a) conducting a survey to establish a definition of "Home Economics" and "Home Economist";

b) conducting a survey to establish what is considered to be the role of home economics in today's society;

c) recommending to the membership that the Association undertake to finance a Home Economist who would assemble data on people, their work and social and economic influences in Canada, and do a parallel study of the development of professional Home Economics, the changing emphasis in academic subject matter areas, and the broadening opportunities for the employment of qualified home economists.

APPENDIX 204

SUBMISSION OF

THE CANADIAN MANUFACTURERS' ASSOCIATION

TO

THE SPECIAL COMMITTEE OF THE SENATE OF CANADA

ON SCIENCE POLICY

April 17th, 1969.

SUMMARY OF RECOMMENDATIONS ON CANADA'S SCIENCE POLICY

a. The Association recommends that the Science Council of Canada, in addition to recommending national scientific goals, should form the nucleus of an independent central office which would facilitate the exchange of scientific information between the federal and provincial government departments, the universities and industry.

b. The Association recommends that the Science Council of Canada should be responsible for: organization of a central inventory on science and technology; studies to determine the nature and economic significance of technological innovation and scientific developments and forecasts of their impact; studies of the research needs of different sectors of the economy; organization and co-ordination of joint research projects; provision of detailed statistics about research and development in co-operation with the Dominion Bureau of Statistics; co-ordination of information on programs of incentives for industrial research and development and provision of information about them.

c. It is believed that the creation of a Federal Department of Science or Scientific Affairs is unnecessary and in many respects undesirable. It is therefore recommended that such a department should not be established.

d. The alternative possibility of naming a minister responsible for science who would have no departmental responsibilities is not considered practicable. It is therefore recommended that such an appointment should not be made.

e. It is recommended that mission-oriented departments or agencies of the federal government should continue to be individually responsible for the objective research essential to their missions.

f. The Association recommends that the government should emphasize strongly the need for placing greater accent on applied science and the innovative process in our universities. In particular, the government should support the establishing of a graduate course in research management in at least one university.

g. It is recommended that the government should encourage the expansion and intensification of the work of the Industrial Research Institutes (in the formation of which it has played a prominent role) as an essential adjunct to the university community.

h. It is recommended that more emphasis be given to placing the role of innovation in its proper perspective and that a greater proportion of government financing for research and development be directed towards the innovation process.

i. The Association recommends that a single channel be established through which all R & D incentive programs and all applications for assistance under them can be handled.

j. Program for the Advancement of Industrial Technology (PAIT)

   i. More flexibility is recommended in the interpretation of eligibility criteria.

   ii. Less technical and accounting detail should be required.

iii. Financing costs should be reduced.

iv. Approvals and assistance payments should be handled more promptly.

k. Industrial Research and Development Incentives Act (IRDIA)

i. Less technical and accounting detail should be required, together with a reduction of the complexity of the program.

ii. The interpretation of the regulations governing IRDIA incentives should be less restrictive particularly where those regulations concern processes leading to the production of new products.

iii. The "sliding five-year base" should be modified.

iv. Approvals and assistance payments should be handled more promptly.

l. Defence Industrial Research Program (DIRP) and Defence Industry Productivity Program (DIPP)

i. The period within which the grant applies should be extended.

ii. The proportion of DRB financing should be increased.

m. The Association recommends that the government should continuously review its taxation policy in an effort to reduce the heavy burden of costs which industry has to bear and which has inhibited its rate of growth.

SUBMISSION OF THE CANADIAN MANUFACTURERS' ASSOCIATION

TO THE

SPECIAL COMMITTEE OF THE SENATE OF CANADA

ON SCIENCE POLICY

THE CANADIAN MANUFACTURERS' ASSOCIATION

1. The Canadian Manufacturers' Association is a non-profit, non-political organization of manufacturers in every kind of product line across Canada. It is sustained solely by the fees of its members whose output accounts for more than three quarters of Canada's total manufacturing production. Significant in the context of this submission is the fact that the size distribution of CMA member companies is similar to that of industry as a whole in that more than 75 per cent of its member firms employ fewer than 100 personnel.

2. The Association has always held strongly to the view that Canada's prosperity is dependent on the progressive broadening and deepening of its manufacturing foundations in conjunction with the development of its export trade. In fact the Association's constitution specifies these two fields of enterprise - industrial and export promotion - as the interests which the CMA is dedicated to serve. In devoting its energies and resources to furthering these objectives, it has concerned itself with a wide range of problems associated with growth and, therefore, change.

THE ROLE OF GOVERNMENT AS CATALYST AND CO-ORDINATOR

3. The Association commends the initiative of the Senate in establishing a Special Committee on Science Policy. As a direct result of this initiative, much welcome attention has come to be focussed on Canada's national goals, its needs and deficiencies and the means by which these needs can be fulfilled.

4. Although Canada's national scientific goals are essentially a long term consideration, requiring long range planning, government, by its very nature, is concerned essentially with short

term objectives and needs. In the Association's view, therefore, there is a basic need for continuing study of long term objectives in this field and the ways and means of achieving those objectives. In the sense that it is part of the strategy of national objectives, therefore, the Association endorses the view that there is a need for a science policy.

5. While science, because of its all pervasive nature, is implicit in, and an integral part of, the total function of government, the process of generating a science policy must be made formal and be given greater prominence. Science policy should in fact become part of the mainstream of debate on national economic goals and means.

6. Clearly the responsibility for recommending national science goals must be vested in some official entity. This entity, in the Association's view, should be the Science Council of Canada.

7. The Association welcomed the establishing of the Science Council in 1966 since it was seen as the means of developing correlated policy recommendations over the whole spectrum of science-oriented activity. The more recent enactment of Bill C-173 establishing the Council as an independent corporation analagous to the Economic Council of Canada has been similarly welcomed by the Association and is seen as a further move to establish the Science Council as the aforementioned entity. The Association believes that this is in the interests not only of the scientific community but also the business community, the universities and the mission-oriented departments and agencies of government.

8. Concern has been expressed in many quarters that scientific affairs in Canada are fragmented to an extent that is detrimental to progress. It is the Association's view, however, that fragmentation of scientific activity is not only inevitable, but may be desirable. Co-ordination, on the other hand, is essential and should be accomplished through the establishing of an independent central office. This office would also function as a clearing house for information about scientific activities and programs.

9. *The Association recommends that the Science Council of Canada, in addition to recommending national scientific goals, should form the nucleus of such an office which would facilitate the exchange of scientific information between the federal and provincial government departments, the universities and industry.*

10. *The Association recommends that the Science Council should be responsible for: organization of a central inventory on science and technology; studies to determine the nature and economic significance of scientific developments and technological innovations and forecasts of their impact; studies of the research needs of different sectors of the economy; organization and co-ordination of joint research projects; provision of detailed statistics about research and development in co-operation with the Dominion Bureau of Statistics; co-ordination of information on programs of incentives for industrial research and development and provision of information about them.*

11. The Association believes that the mechanism of science policy should remain flexible. It has to allow for change and perhaps the best maxim to follow is the one used in the field of automation: define and pursue objectives, then rely on feedback for adjustment. The central office must develop the means of obtaining, on a continuing basis, the views and recommendations of industry, university and government.

12. It will be clear from the foregoing that the creation of a federal government department for the purpose of dealing with scientific affairs is considered to be unnecessary and in many respects undesirable. *It is therefore recommended that such a department should not be established.*

13. The alternative possibility of naming a minister responsible for science who would have no departmental responsibilities is not considered viable. While the proposal has certain attractions, there are inherent dangers in vesting the responsibilities

for decisions affecting mission-oriented departments in a separate minister and, on balance, these outweigh any advantages which might be foreseen. *It is recommended that such an appointment should not be made.*

14. The Association takes the view that mission-oriented departments and agencies of the federal government are best able to determine and decide what research it is appropriate for them to undertake at any given time. *It is therefore recommended that they should continue to be individually responsible for the research essential to their mission.*

THE ROLE OF GOVERNMENT IN EDUCATION AND TRAINING

15. The view that science provides a storehouse of ideas which have only to be picked up and put to use is obsolete; a period of intensive design and development lies in between. It is, in fact, a process of disciplined attack upon one difficulty after another. The question of basic concern to industry, therefore, is how to bridge the gap between the generation of scientific ideas and the final project or product.

16. An essential dimension of the scientific effort must be the educational process by which human skills and genius are developed and directed. The content and quality of programs at all levels of our educational system have a direct bearing on the present and future scientific and technological progress of the nation. In the universities, advanced training in the sciences should be inseparable from the involvement in applied research, engineering and the requirements of industry. The obsolescence rate of scientific knowledge has created the need for engineers and applied scientists who are capable of assimilating new knowledge and living with change.

17. There is evidence that science graduates of Canadian Universities tend to be more oriented to pure research than to applied research. We believe, therefore, that it is necessary to encourage our universities to re-orient their curricula so as to

provide students with greater experience in applied research and give them a better perspective of the challenges and opportunities in Canadian industry. *The Association therefore recommends that the government should emphasize strongly the need for placing greater accent on applied science and innovative process in our universities.*

18. We believe in the necessity for more interdisciplinary training for engineers and applied scientists and more exposure to "real life" contemporary problems. In particular, we believe that these students should receive more instruction in entrepreneurial skills and in the techniques of managing and exploiting technological development. The role of the university in the direct transfer of technology is vital. It has a particular responsibility to act as the "growth centre" for the generation and diffusion of advanced technology. This idea is perhaps best expressed in the charter of the Massachusetts Institute of Technology: "....effective teaching in all its aspects can flourish only when fed by continuous active contact with research and with the realities of our industrial, economic and social life." *The Association therefore recommends that the government should encourage the expansion and intensification of the work of the Industrial Research Institutes (in the formation of which it has played so prominent a role) as an essential adjunct to the university community.*

19. One aspect of importance to the long-term development of Canadian manufacturing industry is the rationalization of production and the increase of our international competitiveness through product specialization. This suggests that new product development and technical innovation offer the most direct and effective ways of achieving these objectives. Consequently, the need for technical managers and development engineers will be increasingly greater if Canada is to move meaningfully towards its national goals. *The Association therefore recommends that the government should support the establishment of a graduate course in research management in at least one university.*

THE ROLE OF GOVERNMENT IN R & D PROMOTION

20. In 1960-61, of a gross expenditure on research and development of $322 million, the Canadian government's contribution was $202 million or 63%. Of the latter figure, $169 million, or 83.7% was "in-house" research, while only $18 million (8.9%) was allocated to industry and $12 million (5.9%) to the universities. On the basis of available preliminary information for 1967-68, the gross expenditure on research and development was $898 million, of which $452 million, or 50.3%, was from the federal government sources. Of the latter amount $298 million or 65.9% was for "in-house" research, $67 million or 14.8% was allocated to support of industrial research and $71 million or 15.7% to the universities.

21. It is commendable that government is channeling a greater proportion of its research and development expenditures to universities and industry and in great degree catalyzing substantial increases in their own contributions to research and development. It is a pattern which we should like to see continued.

22. In terms of our gross national product our gross expenditure on research and development does not measure up to that of other industrialized western nations. While Canada has in the past four years devoted an average of 1.2% GNP to research and development, the United States was averaging slightly over 3%, the United Kingdom over 2%, and the Netherlands close to 2%. Clearly, the scale of support for science in Canada is relatively small as compared with that in most developed countries. However, as the Economic Council of Canada points out in its Fifth Annual Review, "such international comparisons of research and development need to be considered in the light of associated political, historical, social and economic factors. The comparisons, by themselves, can say little about the appropriateness of the levels and ratios, and they tell us nothing at all about the quality of work which is actually being done." It is important to note in this context that many Canadian subsidiaries of foreign companies have access to the research

and development results of their foreign-owned parent companies. Consequently, measurements of Canada's research and development expenditures as a proportion of GNP are not representative of our industrial use of technology.

23. The point is that research and development by itself may be completely sterile. What is crucial is the process which carries the results of research forward into design and through the subsequent process of innovation to the final product. According to "Technological Innovation: Its Environment and Management", a study made for the U.S. Department of Commerce in 1967, only 5 - 10 per cent of the costs in the successful development of some products in the U.S. are attributable to research and advanced development of those products. The balance of the costs are devoted to the innovation process. It becomes clear therefore that the figures quoted account for only about one-tenth of the financial story of successful product innovation.

24. *It is recommended that more emphasis be given to placing the role of innovation in its proper perspective and that a greater proportion of government financing for research and development be directed towards the innovation process.*

25. R & D incentive programs are of special interest to the Canadian Manufacturers' Association. Particularly, we are concerned with their adequacy and effectiveness.

26. Generally, the CMA welcomes and supports the programs of R & D incentives. It is our view that, as a matter of broad policy, government support of industrial research should be considered not so much a cost as an investment from which a worthwhile return can be expected. At the same time there is currently dissatisfaction with certain aspects of these programs and there is need to keep them under continuous review.

27. The need for co-ordination of the incentive programs is emphasized. One common source of complaint is that it is sometimes only by a process of trial and error that a manufacturer can

determine what program is best suited to his individual needs or, indeed, under what program he is eligible for assistance. In this context there is a general feeling that the whole process of obtaining information and making application should be simplified and the decision making process expedited.

28. *It is our recommendation that a single channel be established through which all R & D incentive programs and all applications for assistance under them can be handled.*

The following comments and recommendations refer to specific government incentives for research and development:

29. Program for the Advancement of Industrial Technology (PAIT)

This program has been of help, primarily to small manufacturers, despite its narrow base and rigid eligibility criteria. The cost of financing under PAIT is, however, considered too high. Moreover, administration of the program is too complex in that the technical and accounting data and the general volume of paper work required are often entirely disproportionate to the amount of assistance sought.

The Association recommends:

(a) *the introduction of more flexibility in the interpretation of eligibility criteria under this program;*

(b) *the simplification of technical and accounting data in its administration;*

(c) *the reduction of financing costs; and*

(d) *more prompt handling of applications and assistance payments.*

30. Industrial Research and Development Incentives Act (IRDIA)

IRDIA has provided a useful basis for planning research expenditures and has assisted in the growth of industrial research facilities. It does not, however, work to the advantage of firms already committed to large and continuing research and development programs. It is the Association's belief that the interpretation of the regulations governing IRDIA incentives is too restrictive,

particularly where those regulations concern processes leading to the production of new products. The so-called "sliding five-year base" discriminates unduly against firms with established research and development facilities and should be modified. Uncertainty resulting from delays in the decision-making process has been the cause of dissatisfaction with the program.

The Association recommends:

(a) *Simplification of the program and reduction of the requirements for technical and accounting information;*

(b) *less restrictive interpretation of the regulations governing the program, particularly where those regulations concern processes leading to the production of new products;*

(c) *modification of the "sliding five-year base"; and*

(d) *expediting of approvals and assistance payments.*

31. Industrial Research Assistance Program (IRAP)

This program has met with considerable success, particularly because of its simplicity and straightforwardness and the decentralization of the decision-making process under it. Perhaps its major contribution, the value of which cannot be estimated, is the improvement of industry-government liaison. The program has proven its value and we recommend not only its continuation but the widening of its application to include applied research.

32. Defence Industrial Research Program (DIRP)

Defence Industry Productivity Program (DIPP)

It is the Association's belief that the effectiveness of both of these programs would be enhanced if the grant periods were less restrictive and the long delays pending Treasury Board approval were avoided. It is likewise felt that the proportion of government financing under the programs should be increased.

The Association recommends:

(a) *the extension of the periods within which the grants apply; and*

(b) *an increase in the government's share of financing.*

CONCLUSION

33. The rapidly-growing science-based industries are major contributors to the nation's economic well-being. These industries have quickened the pace of the economy generally and have enriched the career opportunities available to Canadians.

34. New and more conscious ways of insuring long range scientific and technological advances are now required. At the same time there are growing needs for the application of knowledge to adjust imbalances in the economy created by technology itself.

35. It is a major concern of the Association that many companies and industries have failed to grow and develop because they have only been able to serve the demands of the Canadian economy. This is certainly due in part to circumstances which militate against the maintenance of competitive levels of productivity through advanced technology.

36. The Association concludes that government policy should be directed primarily to improving the viability of the manufacturing industry, thereby increasing its contribution to the economy. To make it possible for more manufacturers to compete in export markets, it is necessary to find ways of enabling them to upgrade their technology, improve their innovative capacity, increase their productivity and expand their scale of operation.

37, Essential as it is to define goals as a framework for science policy, it is no less important that there be a favourable fiscal environment within which the forces of enterprise can progress towards those goals. *The Association recommends that the government should continuously review its taxation policy in an effort to reduce the heavy burden of costs which industry has to bear and which has inhibited its rate of growth.*

First Session—Twenty-eighth Parliament
1968-69

THE SENATE OF CANADA

PROCEEDINGS
OF THE
SPECIAL COMMITTEE
ON
SCIENCE POLICY

The Honourable MAURICE LAMONTAGNE, P.C., *Chairman*
The Honourable DONALD CAMERON, *Vice-Chairman*

No. 80

BRIEFS NOT SUPPORTED BY ORAL EVIDENCE:

205—Brief submitted by the Canadian Conference of University Schools on Nursing
206—Brief submitted by H. A. W. Knight, Victoria, B.C.
207—Brief submitted by Jim Lotz, Ottawa, Ontario
208—Statement by the Canadian Dietetic Association
209—Brief by Dr. W. K. Schwarz, Hamilton, Ontario
210—Brief submitted by C.A.H.P.E.R., Toronto, Ontario
211—Brief submitted by the Professional Institute of the Public Service of Canada
212—Brief submitted by Arthur R. Bray, Ottawa, Ontario
213—Brief submitted by Michail F. Smith, Winnipeg, Manitoba
214—Brief submitted by K. O. Bardwell, Ottawa, Ontario
215—Brief submitted by W. R. Smithies, Toronto, Ontario
216—Brief submitted by the Royal Astronomical Society of Canada
217—Brief submitted by the Canadian Association for Education in the Social Services
218—Brief submitted by The Chartered Institute of Secretaries of Joint Stock Companies and Other Public Bodies in Canada
219—Brief submitted by the Members of the Prosthetics/Orthotics Research and Development Unit, Sanatorium Board of Manitoba, Winnipeg, Manitoba
220—Brief submitted by the Canadian Psychological Association
221—Brief submitted by the Canadien Meteorological Society

MEMBERS OF THE SPECIAL COMMITTEE

ON

SCIENCE POLICY

The Honourable Maurice Lamontagne, *Chairman*

The Honourable Donald Cameron, *Vice-Chairman*

The Honourable Senators:

Aird
Bélisle
Blois
Bourget
Cameron
Carter
Desruisseaux
Giguère
Grosart
Haig
Hays
Kinnear
Lamontagne
Lang
Leonard
McGrand
Nichol
O'Leary (*Carleton*)
Phillips (*Prince*)
Robichaud
Sullivan
Thompson
Yuzyk

Patrick J. Savoie,
Clerk of the Committee.

ORDERS OF REFERENCE

Extract from the Minutes of the Procedings of the Senate, Tuesday, September 17th, 1968:

"The Honourable Senator Lamontagne, P.C., moved, seconded by the Honourable Senator Benidickson, P.C.:

That a Special Committe of the Senate be appointed to consider and report on the science policy of the Federal Government with the object of appraising its priorities, its budget and its efficiency in the light of the experience of other industrialized countries and of the requirements of the new scientific age and, without restricting the generality of the foregoing, to inquire and report upon the following:

(*a*) recent trends in research and development expenditures in Canada as compared with those in other industrialized countries;

(*b*) research and development activities carried out by the Federal Government in the fields of physical, life and human sciences;

(*c*) federal assistance to research and development activities carried out by individuals, universities, industry and other groups in the three scientific fields mentioned above; and

(*d*) the broad principles, the long-term financial requirements and the structural organization of a dynamic and efficient science policy for Canada.

That the Committee have power to engage the services of such counsel, staff and technical advisers as may be necessary for the purpose of the inquiry;

That the Committe have power to send for persons, papers and records, to examine witnesses, to report from time to time, to print such papers and evidence from day to day as may be ordered by the Committee, to sit during sittings and adjournments of the Senate, and to adjourn from place to place;

That the papers and evidence received and taken on the subject in the preceding session be referred to the Committee; and

That the Committe be composed of the Honourable Senators Aird, Argue, Bélisle, Bourget, Cameron, Desruisseaux, Grosart, Hays, Kinnear, Lamontagne, Lang, Leonard, MacKenzie, O'Leary (*Carleton*), Phillips (*Prince*), Sullivan, Thompson and Yuzyk.

After debate, and—

The question being put on the motion, it was—

Resolved in the affirmative."

Extract from the Minutes of the Proceedings of the Senate, Thursday, September 19th, 1968:

"With leave of the Senate,

The Honourable Senator Lamontagne, P.C., moved, seconded by the Honourable Senator Benidickson, P.C.:

21564—1½

That the name of the Honourable Senator Robichaud be substituted for that of the Honourable Senator Argue on the list of Senators serving on the Special Committee on Science Policy.

The question being put on the motion, it was—

Resolved in the affirmative."

Extract from the Minutes of the Proceedings of the Senate, Wednesday, February 5th, 1969:

"With leave of the Senate,

The Honourable Senator McDonald moved, seconded by the Honourable Senator Macdonald (*Cape Breton*):

That the names of the Honourable Senators Blois, Carter, Giguère Haig, McGrand and Nichol be added to the list of Senators serving on the Special Committe on Science Policy.

The question being put on the motion, it was—

Resolved in the affirmative."

ROBERT FORTIER,
Clerk of the Senate.

BRIEFS NOT SUPPORTED BY ORAL EVIDENCE

The Committee has received many briefs which were not supported by oral evidence given before it. It has been decided to print these briefs separately from the ordinary proceedings, in several volumes, of which this is the third. The list of briefs printed in this volume is as follows:

205.—Brief submitted by the Canadian Conference of University Schools of Nursing

206.—Brief submitted by H. A. W. Knight, Victoria, B.C.

207.—Brief submitted by Jim Lotz, Ottawa, Ontario

208.—Statement by the Canadian Dietetic Association

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220.—Brief submitted by the Canadian Psychological Association

221.—Brief submitted by the Canadian Meteorological Society

ATTEST:

Patrick J. Savoie,
Clerk of the Committee.

APPENDIX 205

A SUBMISSION FROM THE

CANADIAN CONFERENCE OF UNIVERSITY SCHOOLS OF NURSING

TO

THE SENATE SPECIAL COMMITTEE ON SCIENCE POLICY

<u>Officers of the Canadian Conference of University Schools of Nursing</u>

President	Miss Margaret McPhedran, Professor and Director, School of Nursing, University of New Brunswick, Fredericton, New Brunswick.
Secretary	Miss Jean Goddard, School of Nursing, McGill University, Montreal, Quebec.

FORWARD

The Canadian Conference of University Schools of Nursing expresses to the Senate Special Committee on Science Policy its appreciation of this opportunity to present a statement of views on its role in research activities.

This submission is concerned with the need for research in Nursing and the preparation of nurses to conduct such research.

The purposes of research in Nursing are three fold. The first purpose is to extend the body of Nursing knowledge; the second is to improve Nursing service; and the third is to participate in interdisciplinary studies for the general promotion of health.

TABLE OF CONTENTS

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

The Canadian Conference of University Schools of Nursing suggests that the great shortage of research in Nursing could be alleviated by assurance of funds for the purpose of conducting research projects, developing programmes of graduate study to qualify staff to participate in research; and providing bursaries for graduate study. At the present time, twenty-one universities in Canada have well developed undergraduate programmes in Nursing. Four of these universities have already established programmes of graduate study in Nursing leading to the Master's degree while at least five others have the potential for developing such programmes. However, no doctoral programme in Nursing has yet been established in Canada so that research by students is limited. Members of the teaching staff in all twenty-one universities are qualified to conduct research in Nursing and to participate in multidisciplinary research projects. To give impetus to the development of research in Nursing in Canada the Canadian Conference of University Schools of Nursing makes the following recommendations:

I. That bursaries be provided for doctoral study in Nursing. It is suggested that the amount of each bursary be sufficient to enable students to complete their studies without interruption. At present, such programmes are available only in the United States.

II. That bursaries be provided for study leading to the Master's degree in Nursing and that the amount of each bursary be sufficient to enable students to complete their studies without interruption.

III. That funds be provided to enable universities to establish and expand research activities in Nursing.

IV. That funds be assured to permit continuity of research with a view to attracting and retaining staff.

V. That funds be provided for the development of graduate programmes in Nursing to enable universities to qualify students to conduct research.

VI. That funds be provided for the publication and dissemination of the results of research in Nursing.

SECTION I

THE CANADIAN CONFERENCE OF UNIVERSITY SCHOOLS OF NURSING

1. In 1942, an organization was formed known as the Provisional Council of University Schools and Departments of Nursing. In 1950, the name was changed to the Canadian Conference of University Schools of Nursing. The Conference maintains Associate Membership in the Association of Universities and Colleges of Canada.

2. Until 1968, the membership was individual and comprised the full time academic staff in the faculties and schools of nursing in the twenty-one universities. However, it had become clear that if the Conference were to meet the increasing responsibilities envisaged by its members, reorganization was essential. Consequently, the constitution was revised and adopted at the biennial meeting in June 1968. In order to contemplate the establishment of a secretariat so urgently required, institutional membership was introduced under the new Constitution.

One objective of the Conference is the development of research in Nursing. In 1962 in its submissisn to the Royal Commission on Health Services, the Canadian Conference of University Schools of Nursing emphasized the need for nurses trained to carry out research to determine what is good in the practice of Nursing. At this stage in the development of health services participation of nurses in multidisciplinary research underlines the need for such qualifications.

SECTION II

RECENT TRENDS IN RESEARCH AND DEVELOPMENT EXPENDITURES IN CANADA AS COMPARED WITH THOSE IN OTHER INDUSTRIALIZED COUNTRIES

In the field of Nursing the major comparison of expenditures in research and development between Canada and other industrialized countries would be with the United States. Nursing in these two neighbouring countries has been inextricably linked ever since the emergence of modern nursing.

The first nursing associations were established in common by nurse members in Canada and the United States. Although the move to incorporation necessitated the replacement of these international associations by national organizations close professional relationships have prevailed between the two countries. Added to this, the pattern of nursing education and the development of nursing services have run a parallel course in the two countries.

In various departments of the Federal Government in the United States there are well developed programmes of nursing research. In particular, the departments relating to Health, Veterans' Administration and National Defence have active programmes to support nursing research and the preparation of nurses for research. In providing funds to support students preparing for research the federal government recognizes the expense of such programmes by providing funds to the universities in which such students are enrolled.

It is reported that in the fiscal year 1968 expenditures by the Department of Health, Education and Welfare alone on nursing manpower totaled $129 million. This includes nearly $70 million for preparation of nurses. Part of this sum is used for traineeships for graduate education in nursing and project grants for the improvement of nursing education. The recognition of the importance of developing the scientific base for nursing practice has led to the support of research in Nursing by the federal government. This general statement gives some indication of current expenditures for graduate education and research. Time does not permit a search for specific expenditures in the departments of the federal government of the United States which have been

mentioned and which are known to grant financial support to nursing research and graduate education for the preparation of nurses to conduct research. Such figures will be contained in the annual reports of the departments concerned.

In Canada, twenty-one universities have faculties or Schools of Nursing. Each has potential for research and a great need for nursing research in Canada exists. Encouragement of such research will require the allocation of funds to universities and bursaries for graduate study.

It is anticipated that in the next ten years many more nurses prepared for research will be required if the needs that can be foreseen are to be met.

SECTION III

RECOMMENDATIONS

Nursing is attempting to establish a sound foundation for practice, education, and research. To do this will require a rapidly increasing pool of nurses qualified through graduate study. Very few nurses in Canada hold the requisite Master's or higher degrees.

Bursaries for Graduate Study

1. Recognizing the need for a rapid increase in the number qualified to conduct research, it is urgent that money be made available in the initial stage to enable at least ten new candidates each year to commence doctoral study and to enable those who have already begun such study to complete it. Funds to support doctoral study should increase at the rate at which the pool of candidates for such study increases.

2. It has been recognized that at least twenty-five per cent of nurses in Canada should be prepared in the university. Although enrolment in baccalaureate programs in Nursing is increasing steadily the proportion of nurses graduating from such programs still remains far behind the number required if the target suggested by the Royal Commission on Health Services in its report is to be reached. To prepare sufficient teaching staff for the university schools of nursing alone there should be a very rapid increase in enrolment in graduate study in Nursing.

To meet the rapidly increasing demand for nurses qualified through graduate study will require additional funds to support candidates qualified for admission to programs leading to the Master's degree. It would be desirable to have sufficient funds available to offer bursaries to all candidates who qualify.

APPENDIX 206

BRIEF TO THE SENATE OF CANADA

SPECIAL COMMITTEE ON SCIENCE POLICY

by

H. A. W. Knight

VICTORIA, B.C. 15 MARCH 1969

CONTENTS

Brief to the Senate of Canada

Special Committee on Science Policy

by H. A. W. Knight

Introduction

When one reviews the presentations and discussions of the learned and distinguished people who have appeared before the Honorable Senators of the Science Policy Committee, one wonders if anything significant about science policy can be presented that hasn't at least been touched upon? One concludes probably not. Therefore I shall deal breifly only with points I think need reiteration or that I believe are important and haven't been extensively discussed. Not all the points I discuss deal directly with science policy because as the early proceedings of this Committee have indicated the most important problems concern science and technology in relation to the structures and needs of our society. It is to the area of these relationships that most of my brief will be directed.

Science Policy and Related Problems

Many presentations to the Science Policy Committee have indicated, and I heartily agree, that our main concern should be how can science policy best organize science and technology for the most

beneficial use to society? Science and technology must not be an end in itself but must be used for the good of society. Science and technology without relevance to the needs of society (and we have plenty of this today) leads man, rather than man directing science and technology. Just as there is a tendency for science and technology to be an end in itself and be separate from the needs of society, so there frequently is a working gulf among the physical and biological scientist, engineer, social scientist and artist. This separation is a communications problem. Taken in one form or another lack of communication is, I believe, our number one problem in society. For example how well do we communicate with ourselves? Do we cooperate readily with others for the common good? Are we democratif in all our institutions? Do we encourage participation and feedback from all segments of society? How successful is interdisciplinary or inter-governmental cooperation and planning? Are we working toward world peace, harmony, cooperation and a world language?

Specifically, other problem areas worthy of study are:

1) Education - finance, direction, development, restructuring, and assessment.
2) Health and welfare - financing and benefits.
3) Development and widespread use of mechanisms for democratic decision making and cooperation. For example in all sectors of our society a very few people make all our major decisions (Porter, 1965). Very little attempt is made to get a wide variety of opinion, and then select the best approach from this variety. We do not allow people to participate nearly enough. We thereby

discourage involvement and this leads to apathy and wate of human resources.

4) Authoritative Systems - this problem is analagous to no. 3. The structure of various sectors of our society (industry, governments, universities) hinders participation in decision making at the "grass-roots" level. In professions top to bottom communication is frequently limited. This often blocks new ideas in science and the implementation of results. Proof of the need for restructuring is the evidence presented to this Committee of the poor innovative performance of Canadian science generally.

5) Interdisciplinary Cooperation - One of the major hindrances to solving complex problems like pollution, urban management, or integrated resource development has been the lack of interdisciplinary cooperation. There are efforts being made to correct this lack, but university education still fosters separate professional training. This pigeon-holed teaching and research at universities is a continuation of the isolated approach to subjects in our elementary schools. Our environment is an integrated whole and solutions to our environmental problems must follow this integration. Yet because of our education and our institutional structures we continually offer narrow piece-meal solutions to broad complex problems. The importance of interdisciplinary problem solving has been stressed in many presentations to this Committee. Professor Arthur Porter gave a good example of fruitful interdisciplinary work in citing accomplishments at Expo 67. The importance of interdisciplinary work for solving problems cannot be overemphasized.

6) Tread-mill or Stereotype Thinking - Perhaps the greatest danger to human survival is the difficulty or revaluating and changing the direction of large programs once they are underway. This difficulty has been noted in this Committee's Proceedings regarding research programs. Why do we want to support more and more science and technology without considering its' social effects of greater and greater pollution and environmental change? Are not the important problems how humans react to science, technology and innovation? Why the ceaseless and unlimited exploitation of gas and oil reserves without comparable effort on what this will eventually do to the carbon - oxygen balance of the atmosphere? Why is there so little research on alternative energy sources - like tapping energy from the sun? How do we change direction of our resource development when that development contributes to the livelihood of thousands of people and at the same time may have long-term deleterious effects on public health? It is our lack of monitering and revaluating that leads us from one major crisis to another with all the resulting panic and confusion.

7) Setting Goals - No matter how worthy the goals, objectives and intentions, or the mechanisms for carrying out goals, when governments get together for discussion the views are usually presented from self-interest rather than the common good. There are many goals that cannot be met because of diverging points of view or because of constitutional handicaps.

The Science Council suggests many goals and projects that are long range. Yet there is no department or any government that operates with long term goals. There are many people in government who have made

long range plans only to have them shelved by treasury board cuts, or other departments that jealously guard their borders. The planners soon learn not to think in long range terms for these have little chance of success.

Another hindrance to long term planning is the appointment of deputy ministers or other high ranking officials to senior decision making positions a few years before retirement age. Most of these people are resistant to change because for years their job has been to carry out orders and not rock the boat. Each man who moves up has been trained by those above him in the hierarchy. Traditions and ways of thinking are ingrained and this hinders creativity and innovation. These senior men can best contribute through advice and experience but should not be in a position to block necessary change and innovation.

Most science and technology in Canada has been conducted by the federal government. Therefore scientific goals may be relatively easy to set out. However the major problem is checking on the relevancy and effect of these goals on the various sectors of society.

8) Pollution - The serious water pollution of Lake Erie and other areas, and air pollution by some of our industrial centers has forced action on these problems. However we have not given sufficient attention to soil or land pollution where gigantic problems of solid-waste or garbage disposal, the dispersal of pesticides and the like, face us. New concepts in thinking are necessary if we are to surmount the ever increasing pile of waste materials. Are the current practices of burning or burying the answer when land supply is short and burning adds to air

pollution? We talk of mining the oceans yet largely ignore the unexploited and increasing resource of waste materials.

9) Urban Management - Much progress has been made in urban planning and development through the linking of districts and municipalities into metro governments for common regional goals. These metro governments can then make stronger cases to senior governments for action and financial support. However there are still many large communities that have a proliferation of independently acting districts and municipalities that shun cooperation thus making administration more costly and hindering intergovernment decision making and collaboration. Under these conditions responsibility can be continually shifted, to the confusion and detriment of the taxpayer. Independent studies to update municipal actions would prove profitable for all concerned.

The major problem in urban management is implementation of science and technology to urban problems such as poverty or pollution. Frequently municipal districts lack finances to implement advances in science and technology or to use an interdisciplinary team for problem solving and research. Frequently money to solve problems is siphoned off in administration expense and professional research studies that are never applied.

10) Resource Management - Traditionally we have guided the development of our resources in separate government departments of agriculture, forestry, fishing, mining and so forth. This departamentalization, common to governments and universities, leads to isolated action and frequently wasteful duplication of effort - a pulling apart instead of together.

If we consider our renewable resources, the common basic resource is land (soil and water). These renewable resources should be looked at in relation to each other and managed through the common resource basic to all of them - land.

Forest land and its' products are paramount for Canada's wealth and well being. In the past because of a small population, forest land has been the domain of industry and provincial governements for commercial exploitation. Now however the powerful impact of the Canadian and American public as recreation, fish and wildlife users of forest land cannot be underestimated. Yet do we have plans for forest land allocation to meet these huge, increasing demands for forest land use? Here again interdisciplinary organization and planning of our resources is a prime requisite. This requires restructuring of government departments and the developing of new concepts and programs of cooperation.

11) Foreign Economic Domination - In my opinion one of the most poignant problems for Canada today is the long term effects of foreign ownership of Canadian industry. United States ownership should be of particular concern because of its complete domination and influence of all our major industries.

The advantages to resource development that U.S. ownership brings through new capital, research and technology is well recognized. However U.S. ownership and importing of research and development (R and D) may stifle initiative and R and D Programs here. Why would a U.S.

company want to do research here when they have a similar program back home? Can Canadian companies compete in R and D with large, integrated U.S. companies with huge resources and markets? Are Canadian companies content to buy their knowledge because it seems easier and cheaper? Answers to these questions may lead to the reason why industry in Canada does relatively little R and D, or why there is a large loss of Canadian university graduates to the U.S.A. Even Canadian government incentives have failed to create much new R and D in industry. Yet a country not given opportunities to its brain power is in sad shape.

If Canada had more stringent controls of foreign ownership as all other industrially developed nations have, would we scare off foreign capital for investment? Would our resource development be hindered or our standard of living lowered as has been predicted by Canadian business circles opposed to controls? We don't know for sure, but the easy solution of foreign ownership has certainly hampered Canadian initiative and resourcefulness. Well, what do we do - merely shut the barn door after the horse is gone? We should give high priority to studying what the long term effects of dominant U.S. ownership are on Canadian sovereignty and independent decision making. It appears to me Canada can make a bigger contribution to world peace and harmony by not being locked in to all U.S. economic and political decisions. Yet if we drift as we have been, the locked in position is inevitable. It may now be too late.

12) Foreign Aid and Science and Technology - The main problems here will be determining priority of programs and providing money for support. Increased support is certainly worthwhile for improving world communications, cooperation and well being. As Senator Hays has indicated (p. 998 of these Proceedings) and I agree with him, we have the money to do most things if we would use it efficiently.

13) World Peace - Promote world peace at all leavels of society through research and practice. Transfer some of the zeal, energy and efficiency of problem solving of the scientist and engineer to solving important problems like world peace. We should provide projects and incentives that draw scientists and engineers out of the scientific woodwork to solve problems in the real world.

14) There are many areas of preference for science studies such as weather modification, ocean and space exploration or computer technology. These and similar worthwhile projects in the medical field will have the support of those working in these fields. However, no matter what priorities for scientific development, most projects should be closely oriented to the needs of society.

Problem Solving and Mechanisms

The many, many questions and points on science policy that have been brought forth in the Proceedings of this Science Policy Committee have been in my opinion the first steps to forming science policy. Many of these scientific and related questions have never had such wide discussion in Canada before. Many serious deficiencies have been brought to light. This increase in public enlightenment should provide a broader base for problem solving, a greater participation, and better answers to our major problems.

The key to solving many of our problems is, as emphasized previously, improved communication and cooperation. In addition to the specialized training that our educational institutions provide, there must be centers that foster cooperation through interdisciplinary teaching, research and creativity. Such centers have been brought to light by this Committee, for example the Institute for the Study of Science and Human Affairs at Columbia University. There are a few universities in Canada that will initiate broad interdisciplinary programs this year - Universities of British Columbia and Manitoba, and York University. However after reviewing interdisciplinary programs in resource management at Canadian Universities Martin (1967) concluded that "interdisciplinary combinations remain limited."

To be truly interdisciplinary there should be at least the opportunity and encouragement for the physical, biological and social scientists, engineers and artists to work together solving problems. In addition there should be room for various community groups and certain sections of governments to participate in seminars, courses,

and similar communication and cooperation projects.

The following diagram I believe, could be used as a working model for interdisciplinary teaching, research and discussion or general communication and cooperation. If such a model were put to use at every university or college in the country, we would have made an impressive start to solving many complex problems in society today and we could avoid or anticipate future problems. The benefits and costs of such an interdisciplinary center (for a name I will use Center for Environmental Study) are as follows.

<u>Benefits of a Center for Environmental Study</u>

A. <u>Benefits to College or University</u>

1) Could provide for a broad approach to education with emphasis on a holistic or ecosystem view of our environment and problems.

2) Be an instrument for improving communications between students, faculty and general public; break down the strong ivory tower tendency of universities by orientation of faculty to community problems; provide students with an early opportunity for studying and solving society's problems; increase the relevancy of university teaching and research.

3) Could encourage participation and utilization of talents from outside in the university community.

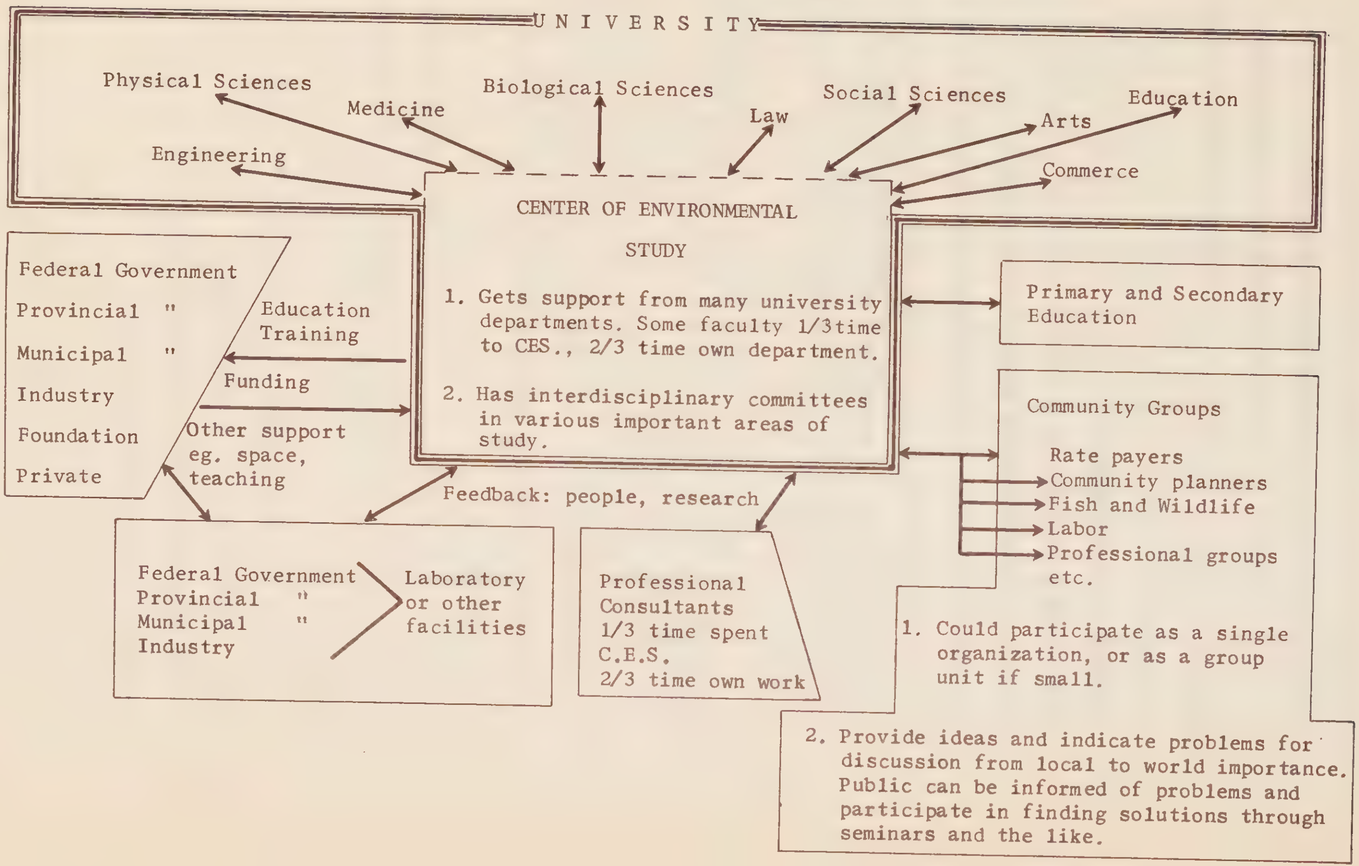
4) Be a center of attraction for recruiting new faculty.

5) Fill the gap in the university education system; offer opportunities for study not now available; be a training ground for interdisciplinary work; can allow a second choice for

Figure I

MODEL FOR INTERDISCIPLINARY COMMUNICATION

A CENTER FOR ENVIRONMENTAL STUDY



students who are not completely satisfied with their current program but wish to use knowledge already gained.

6) Serve to increase collaboration among many professional faculties which will enhance mass assaults on complex problems in society.

B. Benefits to the Community

1) Provide a center for the exchange of many viewpoints from all walks of life so that there will be a broad scientific and community expression on any important topic; could stimulate greater participation and interest in major community, provincial, national and world issues by keeping the public informed.

2) Be a worthy alternative outlet for people's energies and talents.

3) Act as a center for continuous education for the community on social and other issues.

4) Bring to the fore a larger pool of leadership talents from the "grass-roots" level; more people then available to serve with organizations like the Science Council and the like.

C. General Benefits

1) A platform for interdisciplinary communication; a focal point for improving communication; can act as a coordinating mechanism.

2) Allow integrated study of the importance of aesthetics and other intangibles in our environment.

3) Provide independent analysis or assistance to governments, industry or other institutions.

4) Supply society feedback to politicians and scientists who can be made aware of society's problems and needs and thus they can better direct their efforts.

5) It would provide an answer to the question of new institutions for solving tomorrows problems as has been suggested is necessary by the Science Council Report No. 4.

6) Encourage an appreciation and understanding of methods developed by all disciplines for problem solving.

7) A place to unite theory and practice.

Costs of a Center for Environmental Study

The costs of establishing Centers for Environmental Study would be relatively small. The nucleus of staffs are already at even the smallest universities. All that would be required initially is a director for organization. On the other hand if Centers for Environmental Study are not initiated in universities or colleges the cost would be the continued piecemeal, inefficient and expensive approach to many of society's problem.

Recommendations and Conclusions

1) To be most effective the Senate Committee on Science Policy must become permanent. Without permanence much of the good work the Committee has already done or recommendations it might make could easily be neglected. The Committee could become the conscience for all branches of science in Canada.

2) It has been emphasized in this brief and throughout the Proceedings of the Senate Science Policy Committee that our major concern is how science policy can direct science and technology to a greater relevancy and service to all other sectors of society. Our chief problem then is one of communication between science and technology and all the other sectors. By tradition society has developed and operates in many isolated groups. This mode of operating cannot solve many of the complex problems in society today. No matter how high the caliber of science and technology if most of its results cannot be easily communicated and implemented it is little better than working in a vacuum.

3) If we want greater scientific discussion of major projects and goals we have to encourage a broader participation by engineers and scientists. If we want improved feedback from the general public we must be more democratic in our institutions, and keep the public better informed through seminars, continuous education programs and the like. If we want the interdisciplinary programs recommended by the Science Council to succeed we must have centers for teaching and research in interdisciplinary work. If we want universities to have a greater relevancy to community problems we must have places that enhance university - community discussion. In fact if we want to promote communication and

cooperation among the various sciences, engineering and the arts, and at all levels of society, we urgently need centers where this can be done. Therefore for a mechanism of greater communication and participation, and for improved decision making of complex problems, I urge this Committee to recommend encouragement and financial support for such centers. Such a recommendation would be a vital step towards solving many of the problems posed in the Proceedings of the Science Policy Committee.

References

Martin, P. 1967. Graduate resource management programs in Canadian universities. Canadian Council of Resource Ministers, Montreal, Quebec. 19 p.

Porter, J. 1965. The vertical mosaic. University of Toronto Press. 626 p.

Science Council of Canada. 1968. Towards a national science policy for Canada. Queens Printer, Ottawa. 56 p.

Curriculum Vitae and Experience

Name: Harold A.W. Knight

Birth: 28 December 1922

Address: 4190 Glendenning Road, Victoria, B.C.

Undergraduate Training: Victoria College, Victoria, B.C. and University of British Columbia, Vancouver, B.C. Graduated 1950 with B.S.A. degree - major in soils, minor in chemistry and bacteriology.

Postgraduate Training: University of Washington, Seattle, Washington. Graduated 1961 with M.Sc.F. degree - major in tree-environment relations, watershed management and forest ecosystem analysis.

1964, Ph.D. degree - major in forest soils and tree physiology.

Scholarships and Fellowships:

1) University of Washington, 1959-1963, in research and teaching.

2) Visiting Scholar, Departments of Economics, Geography, and Political Science, University of Victoria, 1967-68.

Professional Experience:

1949, land surveyor, B.C. Dept. of Lands.

1950-1958, Research Division, B.C. Forest Service, Victoria, B.C. Project leader in forest soil throughout the province.

1964, consultant in forest land management.

1965-67, Canada Dept. of Forestry and Rural Development, Calgary, Alberta. Canada Land Inventory co-ordinator, implementing programs of federal, provincial and university co-operation.

Currently - consultant in land management and research, and organizer and instructor of forestry course work, Institute of Adult Studies, Victoria, B.C.

Service: 1942-1945, Canadian Armed Forces - Merchant Marine, Air Force, Army.

Membership:

Canadian Society of Soil Science

Canadian Institute of Forestry

Western Forestry Economists

Greater Victoria Art Gallery

Environmental Quality Association

APPENDIX 207

BRIEF TO THE SENATE SPECIAL COMMITTEE ON SCIENCE POLICY

by

JIM LOTZ

It seems to me that we are going through the same phase in "mind" terms during our Electronic Revolution as people went through in "muscle" terms during the Industrial Revolution. It has occurred to me that perhaps, in social science, we already know all we need to know. The problems come with applying social science research to problems solving. In Canada, at least, inadequate attention seems to be paid to the question - what is social science research for? Is it to produce papers, to increase the status of academics, to bat down opponents? I noted from a British review of research topics that the British tradition is still strongly empirical - it seems to be concerned with the real problems of real people. There also seems to be a search, in Britain, for suitable topics for medium and long range research that will pay off in an increase in theoretical knowledge and also aid people in operational situations to obtain a better understanding of what their problems are.

In Canada, it is seemingly easy to get money for esoteric studies from granting bodies, and also to find government agencies who will sponsor the "quick and dirty" study to solve a "pressing problem". But for middle range research that can work in the part of the spectrum between the "pure" and "the applied" aspects of science, there seems to be little enthusiasm or support at this time.

From the size of the grants, it is obvious that people in Britain have some sort of perspective on social science research. The very large amounts of money poured into research in the United States has given rise to a great deal of waste; I served on a United States Arctic expedition and had first hand knowledge of this. Also, in the U.S. a tremendous amount of research has focused on the pathologies of life, and the crash programme approach that attemps to solve

complex problems in a few weeks, has led to disenchantment with research by government and by people.

Development involves the application of science and technology, and there is obviously a need to apply social science to human problems in the same way that mechanical science was used in the eighteenth and nineteenth centuries. Two sets of people are involved in this problem - the government and local people. We have found in Canada that the majority of people in government, even at senior levels do not understand the scientific method or the scientific spirit. They cannot be blamed for this, and there is a tendency for social scientists to talk over the heads of civil servants or to be condescending to them in personal interaction. There is a need in Canada to communicate the results of research quickly and in a suitable form to decision makers. Professor Hillier Krieghbaum of New York University has written extensively on the need to train scientific writers and reporters who can report scientific news. This is important in the physical and the biological sciences. It is vital in the social sciences where our headline world can easily wreck a research project. The other people to be informed are the ordinary people - the taxpayers and the mass of humanity who get through the day without thinking about science, social or otherwise. Many still have the "mad scientist" image. We have found it essential in Canada to work with people, and to respond to their needs. Their problems may seem trivial, but I think it is unimportant where scientists begin. It is how they proceed from there and where they end up that is important. The social sciences are still observational rather than experimental, and experiments in social science means involving people - not playing around with atoms or laboratory animals.

We have developed a special interest in this centre in Community Development. This concept had a false start in the developing world and in Canada -

It was used as a way of tackling complex problems with simple minded approaches. Much of it smaked of magic rather than of science. In Canada, however, we are slowly lurching into the Twentieth century. Massive intervention programmes in socio-economic development and change are being initiated - in the North, in the Maritimes and elsewhere. The urbanization process is squeezing more and more people into the cities. Because of the harsh environment, primary producing economic base, large size and pluralistic population, Canada needs a high level of science and technology to identify and work towards the solution of serious social and economic problems. There is still a tendency for government here to believe that one solves problems, rather than to accept the fact that problems in social and economic development tend to change their shape as time goes by. I see Community Development involving the use of science and technology to create a better life for people, no matter how vaguely defined. It should involve the application of science and technology under controlled conditions where the physical environment, the social structure, the historical record and other factors are taken into consideration. Whatever else is emerging from modern social science research, one dominant need is for social scientists to be human beings before anything else. The thoughtless and uncontrolled application of social science in our century could lead to as much grief and suffering at the mental level as did the thoughtless application of mechanical technology in physical terms in the Industrial Revolution.

Jim Lotz,
Research Director and
Associate Director,
Canadian Research Centre for
Anthropology,
Saint Paul University.

January 2/69

APPENDIX 208

A Statement Presented to
the Senate Special Committee on Science Policy
by
The Canadian Dietetic Association
On the Existing Science Policy of the Federal Government

The Canadian Dietetic Association was asked to submit a brief or other statement to the Senate Committee on the Science Policy of the Federal Government. The views of dietitians have already been incorporated in a number of briefs that have been presented by their respective organizations. However this short statement is submitted to emphasize further the aspects of the policy that specifically concern dietitians.

The Canadian Dietetic Association which represents dietitians across Canada has a number of its members engaged in research. These include nutritionists carrying out laboratory research, field work or nutrition surveys, dietitians participating in co-operative research in hospitals and dietitians working in pure or applied research projects in universities. Their individual research interests include areas in the biological, physical, behavioural and management sciences. In several instances the nutritionist or dietitian is part of a large interdisciplinary group, working on projects that will have a wide range of final application. In their personal positions as members of a particular organization, these researchers have contributed to briefs prepared for submission to the Senate Committee on Science Policy of the Federal Government.

At the request of the Canadian Dietetic Association Executive, members who are familiar with the workings of the present policy were asked to identify inadequacies or strengths in the existing policy which they as

dietitians find of specific concern so that the Association could present its views to the Committee.

A statement based on the answers to the Executive's request follows:

1) The present policy tends to support research in the pure sciences, particularly in the case of grants for research made to universities. There is little support from government agencies for applied research. The implication is that applied research is primarily the responsibility of business enterprises or industry. This has meant that in many sectors, the findings of pure research lie dormant unless a particularly visionary industrialist is able to recognize the possibilities for practical application. If he can see a remunerative potential in the basic research data, only then is he willing to make funds available for further research.

   It is desirable that private industry be encouraged to support research but it is felt that the present policy fails to provide sufficient incentives in the form of tax concessions beyond any that may presently be available are what is needed to increase both the amount of support and the number of industries willing to sponsor, alone or with the Government, more applied research at universities.

   There are numerous areas that could be used to illustrate the existence of an unnecessary gap between pure science research findings and practical application of the data. The Canadian Dietetic Association

is most concerned about the large amount of important knowledge which exists from biological and physical research on foodstuffs. This knowledge, with further applied research could contribute to the improvement of quality and quantity of foods, through better methods of food processing, preservation, storage and distribution. Such improvement could increase the nutritive value and safety of food and lower the cost to the consumer.

2) There is inadequate support for interdisciplinary research. Many grants are made by agencies that have a specific orientation, i.e. social science or biological science, and unless the research project is within this particular orientation, these grants are not available. Research in areas such as human nutrition, because of the interrelationship particularly of biological and social sciences, could be more productive if approached as an interdisciplinary research projet. The Canadian Dietetic Association recommend a revision of the policy, regarding interdisciplinary grants to incorporate more of the concepts in this area now followed by the National Health Program and the Killam Awards.

3) In that Government agencies usually have a specified amount of money for research and in that the agencies usually know what research they are prepared to finance, it is recommended that the agencies offer a lump-sum of money to selected institutions for research in specified areas designated by the granting agency.

Grants for research are usually given to individuals rather than institutions. This has the advantage that grants can be given to experienced research workers on the basis of their former publications. However, an individual can be given a grant only when he is attached to an institution which guarantees his salary. This places an unfair burden on the institution unless an additional grant is given to the institution as "overhead" for the research project, to cover such items as electricity, library facilities and other non-budgetted items. The same situation arises when a graduate student is given a scholarship for research without any grant being given to the institution to defray expenses of the student's research project. If the grant were given to the institution an individual in each institution could be selected to coordinate the program and to receive the grant on behalf of the institution. This need not necessarily be the originator of the idea. If the grant were given as a lump sum such a scheme would provide the opportunity for the institution to allocate the funds to departments best equipped to carry out each phase of the project. The granting agent could require that a budget be made out to show how the allotted sum was to be spent and that the institution provide, at intervals, an account of how the money had been spent.

4) In that the government financial year runs from April 1 to March 31, whereas the academic year at the university runs from June 1 to May 31, difficulties arise concerning the efficient utilization of research grants. If it were possible for grants to be made during the government year but spent during the academic year, then money could be saved for supplies and salaries during the months of April and May. As it is at present, all money must be completely spent before March 31 and unless the grant is being renewed there is nothing available for expenses during April and May.

APPENDIX 209

BRIEF SUBMITTED

to

THE SENATE SPECIAL COMMITTEE

on

SCIENCE POLICY

by

Dr. W. K. Schwarz,

921 Scenic Drive

Hamilton, Ontario

Preface

The present submission recommends the creation, by the Federal Government, of a centre for the systematization of sciences. Conceptualization is not enough. Conceptualization without systematization moves erratically, often in contradictions. A centre for the systematization of sciences would

1) establish through research and publication of its results the architectonics of all principally possible sciences to assure a balanced government support of sciences that does not leave out fields of vital importance,

2) review and assess topical issues and new trends in particular sciences from the strandpoint of man's autonomy in his theoretical and practical functions,

3) advise scientists of the natural and applied sciences on questions of principle in cognitive methods,

4) act, through the determination and dissemination of a system of sciences, as a unifying force for all scientific activities; it would at the same time provide, through its determination of innerent primacies, a general criterion for decisions in science policy, and possibly not only for policy decisions in regard to science.

This submission is limited to the terms of paragraph d) of Appendix A of the Guide for Submission of Briefs, outlining what ought to be done rather than what is being done in science policy (the reference of paragraphs a), b), and c)).

1. Our "new scientific age" is characterized by an imperialism of methods, to which we owe, as an expression of the scientific virtue of consistency, great advances in certain fields of knowledge. In its uncritical and intolerant applications, however, it has contributed to the extinction of three fundamental sciences, which because of the difficulty of their abstractions can thrive only in a climate of restraint and objectivity. Concern is frequently voiced about man's failure to develop, along with his great strides in natural science, a science that would instruct him in what general manner and toward what general end he should employ his increased knowledge and domination of nature. Man is not naturally or "by nature" living the "right" life but has freedom of choice to make his a life of order or disorder. The abuses of man's freedom in our century need no illustration. That a science of the right use of man's freedom has sunk into insignificance or even disappeared in our time, may also be inferred from paragraph a) of subsection 2.6) of Part II of the Committee's guide for the submission of briefs. Under the caption Scientific Discipline, this paragraph enumerates the most prominent modern sciences, but does not cite a science of right human conduct. The decline of philosophy into a cultivation of merely subjective irrelevancies, if not immoralism, may be exemplified by just two instances:

a) Cambridge Philosopher G.E. Moore, considered by many to be the most influential moral philosopher of our century, wrote:
"...we may state the first principle which our theory lays down quite briefly by saying: 'A voluntary action is right, whenever and only when no other action possible to the agent under the circumstances would have caused more pleasure; in all other cases it is wrong'".

b) A.J. Ayer, prominent representative of "logical positivism", calls ethical concepts "mere pseudo-concepts": "...sentences which simply express moral judgments do not say anything. They are pure expressions of feelings and as such do not come under the category of truth and

falsehood" (quoted from 'Readings in Ethical Theory', ed. Sellars, Hospers, N.Y., 1952, pp. 43,396,398).

These statements are symptomatic of the loss caused by a dominance of positivistic or naively empiristic methods.

2. In their present state, the so-called "social" or "behavioral" or "human" sciences - the "humanities", the "liberal arts" - "psychology", "sociology", "political science" - all expressions used in a wide variety of divergent meanings - offer a mixture of, on the one hand, factual (at best) and, on the other hand, normative content. A Swiss philosopher, Paul Häberlin, is to my knowledge the only one who, before venturing on something as indistinct as psychology, wrote an entire book (in the nineteen-twenties) on the subject: 'Der Gegenstand der Psychologie' - the object of psychology. Following his logic where it carried him, he ended up with the desparado solution: Psychology is natural science, and: all natural science is psychology. Today new "sciences" are arising without any definite concept of their object and methods, let alone an investigation of their possibility. The undisciplined mixing of individual volitions and hopes into what should be a theory of some segment of reality is commonplace in the afore-cited "sciences", as for instance a "cultural anthropologist" admonishes us to carry out purposive, conscious and responsible intervention in cultural evolution "in terms of worldwide system", while at the same time declaring that there is no general idea of what to look for and in what direction to work. The same source advises us that certain schools of thought more recently have shifted their naturalistic observations from apes and monkeys to tortoises, spiders, cockroaches or, for that matter, rats, as "approaches to man" (Margaret Mead, 'Continuities in Cultural Evolution', New Haven, Yale University Press, 1964, p. 10.

3.a) A scientific determination of the criteria of right human conduct is possible, not as someone's artifact or invention, but as an abstract formulation and vindication of common morality, which, as is little understood, rests

on a priori laws of freedom. Such a science does not abet regimentation. It defines and vindicates universal practical principles and ends, leaving scope, in execution, to the individual's choice of concrete ends. The foundation of this doctrine of freedom (eleutheronomy) is susceptible of scientific treatment, since its elements are given a priori and none but self-contained conceptual relations are under investigation in its pure part. In its legal conformation, as a doctrine of (natural) law, it formulates principles of domestic and international peace. As this science of the highest importance is missing in our time, one must wonder how well it deserves to be called a "scientific age".

3.b) Since the positive determination of freedom and its laws - and thereby the determination of the legally and ethically right practice - compels us to seek a reconciliation of freedom with nature's determinism, an epistemology is required. The science performing this task will also be a valuable guide for nuclear physicists coping with borderline problems of their science. It is not to be expected, nor desirable, that natural scientists become "metaphysicists", though some have been driven, by their theoretical quandaries, to become dogmatic metaphysicians. There should be scientific "generalists" whom specialists may consult concerning their general problems, such as, e.g., the reach of the category of causality, the merit of critical phenomenalism as opposed to materialistic naturalism, etc. Again this theoretical complement of a practical science of human conduct has become lost in our time in fragmentary linguistic analyses or the formalisms of mathematical logic. The 1957 Nobel prize in physics was awarded to dres. Lee and Yang for their disproof of parity conservation in weak interactions, which toppled the so-called "parity" law of physics (space reflection symmetry). This so-called law would never have received honour, and long detours through extraordinarily costly experiments would have been avoided, had there been critically trained physicists with an awareness that "different positions in space already make distinction of objects

as phenomena without further conditions not only possible but necessary. Therefore that seeming law (Leibniz's principium identitatis indiscernibilium, which is implied in "parity") is no law of nature. It is an analytic rule of comparing things through mere concepts".

3.c) The third fundamental science, submerged today by the grosser effluxions of the atmosphere that surrounds us, is a critical teleology which determines the principles of man's aesthetic perceiving and creating and of an understanding of nature's apparently purposive organizations.

4. The very abstractness of this threepartite science - a reflection of a priori forms of the human mind - makes it a luxury no more than mathematics, because of its abstractness, is a fruitless passtime. To those who lack good-will, the absence of these three sciences, most of all its practical division, is a welcome sign that mankind nowhere knows the idea of a unifying purpose. Some teachers whom one would expect to be the guardians of these sciences, saw fit to join their rioting students, rioting, as it were, against themselves.

Conclusion and Recommendation

An efficient science policy presupposes a definite concept of "science" and an idea of the system of sciences (lest perchance it ignore the necessary). From a systematic idea, the general priorities of scientific activities and science policy will become settled, so to speak, automatically. To carry out this groundwork of an efficient science policy, it is therefore proposed here

a) that the Federal Government create a

Centre for the Systematization of Sciences.

Such a centre would inevitably direct attention to the absence of a science of the laws of freedom as outlined above in paragraph 3.a). Universities have failed to develop this science: - "Professional philosophy (where one might expect to find it), reflecting popular philosophy, is likewise variegated, chaotic, fadistic, suffused with antagonisms, and struggles to include or exclude vociferous futilitarianisms" (A.J. Bahm in the University of New Mexico

15th annual research lecture 'Philosophy-1968'). Governments cannot be indifferent to the possibility that efforts and funds expended on the never-ending and increasingly costly enterprises of technology may be brought to naught by forces who exploit the vacuum of this missing science. What is of the greatest necessity and cannot be obtained elsewhere, governments must therefore, if not create, at least try to foster themselves. The proposed centre for the systematization of sciences could be instituted as an independent government agency or be added to an existing one. It would

1) establish through research and publication of its results the architectonics of all principally possible sciences to assure a balanced government support of sciences that does not leave out fields of vital importance,
2) review and assess topical issues and new trends in particular sciences from the standpoint of man's autonomy in his theoretical and practical functions,
3) advise scientists of the natural and applied sciences on questions of principle in cognitive methods,
4) act, through the determination and dissemination of a system of sciences, as a unifying force for all scientific activities; it would at the same time provide, through its determination of inherent primacies, a general criterion for decisions in science policy, and possibly not only for policy decisions in regard to science.

In free countries the receipt of funds from governments for cultural purposes is always assumed to constitute no obligations whatever as to the content of the activities so subsidized. There is a fallacy in this assumption. The tacit, if not explicit stricture is that the recipient must not use the funds received for purposes injurious to civil government. Presupposed in the government's paying for scientific development is a commonness of purpose. If a

person wants not to be accountable to others in the use of certain funds, he must have either earned them himself or received them charitably. It is therefore also recommended

b) that the Federal Government state those common purposes which it wants furthered through its support of scientific activities, naming others of dubious character to which it does not want to give assistance, in the sure knowledge that the conscientious citizen would never consent to those activities.

APPENDIX 210

BRIEF TO THE SENATE SPECIAL COMMITTEE ON SCIENCE POLICY

by

C.A.H.P.E.R.

149, Alcorn Avenue,

Toronto 7, Ontario.

The purposes of the Canadian Association for Health, Physical Education & Recreation Research Committee are to encourage investigation in health, physical education, recreation, sports medicine and related fields; to be aware of current and past research work and attempt to co-ordinate research efforts in Canada.

The Committee is composed of those members who satisfy the following requirements:

(1) are professional members of C.A.H.P.E.R.

(2) have published in a recognized research periodical

(3) are actively engaged in research.

The present members of the committee are:

Name	Degrees	Address
D.A. Bailey,	P.E.D.	University of Saskatchewan
S.R. Brown	Ph.D.	University of British Columbia
E. Doroschuk	Ph.D.	Laval University
F.J. Hayden	Ph.D.	University of Western Ontario
M.L. Howell	Ed.D.	University of Alberta
F. Landry	M.S.	University of Ottawa
R.B.J. Macnab	Ph.D.	University of Alberta
G. Metivier	Ph.D.	University of Ottawa
W.A.R. Orban	Ph.D.	University of Ottawa
M.S. Yuhasz	Ph.D.	University of Western Ontario

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The objectives of the Committee are as follows:-

(1) to plan, organize and conduct the research sessions at the Biennial Convention of C.A.H.P.E.R.

(2) to work co-operatively with other Committees of C.A.H.P.E.R.

(3) to represent the Association in matters pertaining to research.

(4) to prepare and disseminate information related to research

(5) to conduct studies vital to the advancement of the profession.

The Committee is at present mainly concerned with the evaluation of the Canadian population with respect to their capacity to do physical work (Howell, M.L. and Macnab, R.B.J., 1968: appendix 1; Orban, W.A.R. and Metivier, G. to be published) as well as observing their performance during specific fitness tests (Hayden, F.J. and Yuhasz, M.S. 1966: appendix 2) Although the performance tests are not considered as being wholly indicative of maximum aerobic work capacity, they are considered of importance in task performance. It is believed these findings will be indicative of the aerobic work capacity of our population and will provide information concerning the needs of our present adult and school-age population.

The Research Committee relates directly with such organizations as the Canadian Medical Association, the Canadian Association of Sports Sciences and it is anticipated in the near future there will be a working relationship with the International Federation of Sports Medicine.

The Committee believe support should be considered toward an agency that is national in its outlook and has the co-operation and interest of Canadian Universities and most medical institutions and organizations in Canada.

It is the Committee's opinion that the three following areas of investigation are of prime interest:

(1) motivation with respect to physical activity and current health problems such as smoking,

(2) benefits of physical activity, the value of sport, and

(3) longitudinal studies in growth and development.

C.A.H.P.E.R. is a non-profit, non-governmental voluntary membership organization of people engaged in health education, physical education and recreation education in Canada.

The Association has been concerned to improve programs and the professional preparation of personnel engaged in the field. To this end a Research Committee was established in 1961.

A three phase investigation was planned in 1963. Two phases have been completed. (see appendices No. 1 and No. 2.)

The Research Committee arranges meetings at each of the Biennial Conventions at which members report on research projects which are in progress or completed. The Association endeavours to publish in its Journal abstracts of the research papers as presented. (see appendix No. 3.)

The Science policies of the Association are determined by the Board of Directors in close consultation with the Research Committee, which is responsible for organizing and conducting studies and research. Presently there is a move to broaden the range of projects to include motor learning, sociology of sport and historical research.

February, 1969.

APPENDICES

No. 1.
Chief Investigators

Hayden, F.J. and Yuhasz, M.S. (1966)

The CAHPER Fitness-Performance Test Manual.

Toronto: The Canadian Association for Health, Physical Education and Recreation.

No. 2.
Chief Investigators

Howell, M.L. and Macnab, R.B.J. (1968)

The Physical Work Capacity of Canadian Children.

Toronto: The Canadian Association for Health, Physical Education and Recreation.

No. 3.

Research Abstracts (May, 1966)

Toronto: The Canadian Association for Health, Physical Education and Recreation.

APPENDIX 211

BRIEF TO THE SENATE OF CANADA

SPECIAL COMMITTEE ON SCIENCE POLICY

BY THE

PROFESSIONAL INSTITUTE OF THE

PUBLIC SERVICE OF CANADA

I. INTRODUCTION

As a group of scientists currently engaged in scientific research we feel that we have a viewpoint which has not yet been submitted to the Special Committee. Previous submissions on Science Policy have come from various administrative bodies such as the Science Council, and the management of Research Organizations.

Rather than obscure the issue by the use of such difficult to define terms as "mission oriented" or "pure" and "applied", we shall give our views on how research and development should be allocated among four different agencies engaged in the practice of science. In doing this we are concentrating on section d) in the Order of Reference of the Special Committee, because we feel that broad policy decisions are necessary before considering the more detailed questions posed by sections a), b), and c) of that document. The recommendations are given at the end of this submission.

2. THE FOUR GROUPS CONCERNED WITH RESEARCH AND DEVELOPMENT

The responsibilities for carrying out scientific research and technological development are spread among Industry, Provincial and Testing Laboratories, Universities and Federal Government Laboratories. We will give a brief description of their proposed responsibilities, and then discuss these proposals in more detail in the later sections of the submission.

Industrial laboratories are mainly devoted to a combined research and development effort. In the main, the work is product-oriented.

Provincial and Testing Laboratories usually work on short-term problems for industry or the local community.

Universities have a dual function of teaching and research, the latter being a necessary adjunct to the training of research students.

Federal Government Laboratories have a variety of responsibilities, among which are to conduct research on behalf of sectors of the economy (such as agriculture), the maintenance of standards, in-house activities related to defence, and the basic research necessary to support these functions.

Our recommendations for these four organizations and the reasoning behind these recommendations are given in the next four sections.

(i) Industrial Laboratories

In the boradest sense the purpose of science in industry should be the adaptation of existing knowledge to problems of production and design, supplemented, if possible by the exercise of techniques and recently developed processes in order to keep abreast of current practice. Although most of this science is usually for use within the Company, some industrial laboratories may engage in research for sale outside the Company.

The level of scientific research and development in industry in Canada, both with regard to the number of personnel involved and work carried out is too low in comparison with the total scientific effort of the Country. It is to be hoped that a more balanced distribution of scientific activity will be reached by increasing the amount of industrial work without decreasing other types of scientific undertaking. This increased effort will, initially at least, require federal encouragement and assistance.

(ii) Provincial, Testing and Consulting Laboratories

These laboratories, as a rule, carry out very little basic research. Much of the work is of a development or testing character and mainly involves the application of existing knowledge. Some research and development should be done in relation to local problems. Investigations such as those associated with oil and coal in Alberta, sawdust in British Columbia or process industries in Ontario are best handled by those nearest the problem. Collaboration may develop between provincial and industrial activity, as in the case of the Sheridan Park

research estate in Ontario. The university may play a part in supplying consultants and part-time students, although a world of warning should be heeded about the possible diversion of university effort away from their principal mission, i.e. education. The projects engaged in by such organizations should be problem oriented and such work which does not promise returns in the foreseeable future should be discontinued.

A second type of "Consulting Laboratory" is one which is set up by a group of related companies, such as the Pulp and Paper Research Institute in Montreal. This type of Institute may engage in long-term applied research on common problems for the whole industry. Federal assistance in starting and possibly maintaining this sort of laboratory is probably desirable.

(iii) Universities

It should be borne in mind that the principal function of science and engineering faculties in universities should be education and training of scientific specialists. Research is an important aspect of this activity, as scientists and engineers embarking on a life in research have to be trained in the closest possible connection with original investigations at the frontiers of knowledge. However, university research activity must by nature be of a "low risk" type, each problem promising from the outset a return in original results within the space of time allotted to a master or doctorate course. We consider that universities should not set up institutes of specialized function devoted entirely to research. In addition, such institutes will most likely be financed from federal grants and the question whether research in the institute might not have been undertaken by government directly, naturally poses itself.

Research in universities should be intellectually unconfined; the problems tackled should flow from the natural development of science and the researcher's personal aptitude and inclination, bearing in mind the limits set on time of completion, mentioned earlier.

(iv) Federal Government

We consider that the federal government has an important role to play in research, principally where such work is of long-term nature, is likely to be expensive, or supports a special function of the government, such as national defence, or nuclear power. In the biological field, the government has an important place in the development of disease resistant and climatically adapted food plants and the control of pollution, as well as the monitoring of drugs and additives likely to be harmful. Other important functions are the maintenance of standards of measurement and research into such fields as transportation methods and control. This naturally involves the operation of large and expensive facilities, such as experimental farms and wind tunnels. Moreover, only government laboratories are and should be in a position to undertake "high-risk" research, in which the ultimate success is not assured from the outset, but for which the probable benefit for the Country may be very high. An example of this kind is nuclear fusion research, an inquiry into a form of energy for which the fuel cost is likely to be so low, that immeasurable benefit to the country may accrue. In Canada, where funds available from other sources are unlikely to be very large, the federal government must play the part of scientific trailblazer in such high-cost fields. Because of its ready access to large funds, the federal government should and does run expensive research facilities such as radio telescopes and rocket ranges, which are at the disposal of the universities.

It should be obvious that, in spite of the large part the federal government plays in "mission oriented" research, a material fraction of its effort must be directed towards fundamental investigations. It has been pointed out by many authorities that no mission-directed research can succeed for long without the back-up from and access to the results of fundamental research. The maintenance of measurement standards, for instances, involves nearly the whole of physics in its domain, mining involves a large proportion of inorganic chemistry. Financial needs of fundamental research in most fields are relatively small; at the present time, the funds devoted by the National Research Council to basic research constitute little more than ten percent of the total budget for in-house

research. Yet the benefits are immeasurable, as the Council has at its disposal a large number of experts in many fields of basic research, always able to render aid and advice to the applied fields and other government departments and able to strike out into new and promising fields. As always, best results are achieved in this area if the individual researcher is allowed to "have his head", within the limits drawn by his consultative commitments and the available budget.

Consideration should perhaps be given to expanding the arrangement in which university students do a major part of their research in government laboratories. Without interfering with the programmes of the laboratories or with university autonomy, the students are thus enabled to make use of the fine and expensive research facilities of the government. The research programme is supervised, and the resulting degree granted, by the university concerned. Hence, the government research organization can fill the requirement for costly institutes which are being proposed by some universities. The appended table is a summary of the proposed distribution of responsibilities for research in Canada.

3. RECOMMENDATIONS

(A) Industrial research laboratories should concentrate on research directed to the improvement of industrial products and rationalization of production methods, supplemented by some research on general lines to help the Company keep up with developments in the field. A considerable increase in both the level of research funds and the number of research workers is desirable and initially, the federal government may have to shoulder some of this burden.

(B) Provincial and private consulting laboratories should concentrate on local problems and others originating with private users, not necessarily connected with industry. Laboratories of the type of cooperative research associations should be encouraged and, if necessary, founded with federal support.

(C) Universities should consider their prime function to be education; a sufficient level of research should be maintained to enable the training of post-graduate research students. We do not believe that federal government research institutes should be transferred to universities to form research institutes. We recommend that where expensive equipment is required part-time in a university department, that its use be made available by gouvernment research laboratories. This will ensure the most efficient use of costly facilities.

(D) Federal government laboratories must engage in investigations associated with the nation as a whole, such as measurement standards, agriculture, natural resources, transportation and control of noxious substances including pollution, and special, classified projects, such as defence research. All government research organizations, but particularly the National Research Council should look into the future and engage in investigations of a long-term nature of which the final outcome is not immediately known. This will include a proportion of basic research, the direction of which should be in part determined by the individual research worker.

February, 1969.

Responsibilities of Research Laboratories in Canada

Industrial	Provincial and Testing	Universities	Federal Government
Product Oriented Research to keep ahead.	Localized problems. All work problem oriented and short-term.	Mainly teaching with research as a teaching tool.	General long-term problems (e.g.) Agriculture. Special (e.g.) Atomic Energy, Armed Forces
		Uncomitted Research	Expensive.
		Suitable for graduate degrees.	Standards Methods Materials
		Consulting (Limited)	Industrial Assistance and

THE PROFESSIONAL INSTITUTE OF THE PUBLIC SERVICE OF CANADA is an organization of 12,000 professional public servants founded in 1920 and incorporated under federal legislation in 1950. Amongst its membership the Institute represents over 4,000 Scientific Personnel employed by the Public Service of Canada, Defence Research Board, National Research Council and Fisheries Research Board.

The objectives of the Professional Institute are to enhance the usefulness of the Public Service of Canada, to maintain high professional standards and to promote the welfare of its members.

APPENDIX 212

February, 1969

BRIEF

TO

THE SENATE OF CANADA

SPECIAL COMMITTEE ON SCIENCE POLICY

" SCIENCE, SOCIETY & THE UFO "

BY

ARTHUR R. BRAY

1187 Agincourt Road,

OTTAWA 5, Ontario

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<u>CURRICULUM VITAE</u>

BRAY, ARTHUR REID, C.D.,

Mr. Bray was born in Ottawa, Ontario in 1925 and attended Lisgar Collegiate there. Joined R.C.A.F. upon graduation in 1943 and trained as a pilot. Transferred to Royal Navy in 1945 as a pilot and was granted a commission shortly thereafter. He subsequently transferred to the R.C.N. In 1951 he qualified as a Supply Officer and has served afloat and ashore in various capacities. Has undertaken courses both within the Service and apart from it, in accounting, management, personnel administration, military logistics and computer operations, among others. Through private study and research over a period of twenty years he has advanced his education in the arts and sciences to a point where he wrote and published a book concerned with science, philosophy and other aspects of the humanities which has been described as at least the equivalent of a university thesis for a degree (title -- SCIENCE, the PUBLIC AND THE UFO). Mr. Bray now holds the rank of Lieutenant Commander and is currently serving in Canadian Forces Headquarters. In 1967, he was awarded the Centennial Medal.

Memberships:

- Canadian Aeronautics and Space Institute
- Society of Technical Writers and Publishers
- Royal Astronomical Society of Canada
- Toastmasters International
- National Investigations Committee on Aerial Phenomena
- Canadian Aerial Phenomena Research Organization
- National Geographic Society.

SUMMARY OF MAIN CONCLUSIONS AND RECOMMENDATIONS

SUMMARY OF MAIN CONCLUSIONS

Little progress has been made in twenty-one years of official investigations of the UFO phenomena. Despite the fact that most scientists shy away from the subject, there are some prominent ones who insist the problem is vital and urgent and requires thorough study on a wide-spread scale. These few are supported by many thousands of private researchers who give of their own time and money in an effort to find the truth of the matter.

There can be no doubt of the existence of UFOs. The question is -- what are they? And this question leads to the next -- why are they here, or what are they doing?

Man-made objects and known natural phenomena do not explain the truly unidentified objects. This unknown percentage comprises the objects with which I am concerned. The hypothesis which is most suitable at the present time is that at least some UFOs are intelligently-controlled interplanetary space vehicles and the observational evidence supports this. The fact that such a hypothesis may seem unlikely to some does not invalidate it, despite what many scientists say.

Although various scientific investigations have been conducted into this matter over a period of two decades, none of them have succeeded in solving the problem. If UFOs are merely unknown natural phenomena, why has science not been able to discover what these phenomena are? Whether visiting space ships from other worlds, or terrestrial natural phenomena, the mystery remains unsolved. This is so primarily due to the limitations of the investigations conducted, and of the scientists themselves. The orthodox barrier

is an obstacle to the advancement of science and a major change in attitude is required in order to cause the collapse of this barrier.

Apart from the scientific aspects, the possibility of UFOs being interplanetary (or interstellar) vehicles should not be rejected on philosophical grounds. The actions of any such intelligent beings should not be judged in relation to our own reasoning.

Humanitarian considerations should be the real objective of all scientific advance, otherwise there is no point to scientific inquiry. The advantages, or otherwise, to the human race on Earth, are vital and sufficient reasons to solve the UFO mystery at the earliest possible date. Investigations over a period of twenty-one years have got us nowhere, but the problem persists.

RECOMMENDATIONS

It is recommended:

1. That the Government immediately recotnize UFO phenomena as being of major scientific significance and deserving of serious study, in an effort to remove the stigma attached to scientific and public discussion of the matter;

2. That the Government recotnize that the UFO mystery has remained unsolved due to inadequate investigations, and not due to the non-existence of unknown objects in our skies;

3. That complete factual information be released in which the public can have confidence, to reduce the confusion and misunderstanding. Such an act will also encourage people to report their sightings for scientific analysis, instead of keeping them to themselves as is more often the case;

4. That Canada take the lead in UFO investigation by establishing a thorough and fully-objective study of the phenomena, not limiting this study to a few narrow scientific fields as has been the case. Many fields of science,

technology and the humanities must be included in this study;

5. That this study be supplemented by an attempt to build a new model of the universe, not limited to known physical laws, but which would permit interstellar travel in short time periods. This task requires, first, a recognition by Science of the possibility that existing models could be false. In other words, scientists must knock down their own "orthodox barrier";

6. In conjunction with recommendation 4, and concurrent with it, that Canada strongly encourage other nations to establish similar investigations on the same basis;

7. That further to recommendations 4 and 6, Canada encourage the United Nations Organization to co-ordinate such national investigations and to establish a control or "filter" centre to assimilate sightings and local patterns to determine global patterns (with the assistance of computers) in order to obtain the overall comprehensive world-wide view of the situation, which may lead to an eventual solution.

SCIENCE, SOCIETY AND THE UFO

INTRODUCTION

1. As I am a serving officer in the Canadian Armed Forces, I must first make clear the following points:

   (a) The contents of this brief, and the opinions expressed, are strictly those of the author;

   (b) Such opinions are in no way based upon information gleaned from the Department of National Defence files;

   (c) This brief does not contain any information gleaned from Department of National Defence files; and

   (d) So far as I am aware, the opinions or recommendations do not in any way reflect policy of that Department.

2. In submitting this brief it is my purpose to draw to your attention, for your consideration, certain facts pertaining to the great world-wide mystery of Unidentified Flying Objects, or UFOs, which is a phenomenon of as much concern to thinking Canadians as to the rest of the world.

3. By UFO, I refer specifically to those flying objects which, after thorough investigation, cannot be explained as being man-made objects or known natural phenomena; that is, they remain unidentified. The investigation of these phenomena has come to be known as Ufology.

4. The first question I must answer, probably, is why am I bringing this matter before the Senate Committee on Science Policy? In answering, I must first make it clear that this is a matter which has continued, wrongly I think, to remain beyong the grasp of science despite the frequent pronouncements of many scientists that they can explain all UFOs as weather inversions, balloons, ionized particles, astronomical bodies, swamp gas, hallucinations, hoaxes, and a myriad other man-made objects or natural phenomena. A large portion of the public is unwilling to accept these casual and blan explanations

that are so frequently offered, as they know they saw something else.

5. As I stated, this is a world-wide problem, so all nations are immersed in this enigma whether they like it or not. As it is my view that all nations need to investigate UFOs properly and thoroughly, I hope that my bringing the matter to your attention can provide some impetus for Canada to do something about it, and thus to encourage other countries to do the same.

6. It is also my view that little progress has been made in twenty-one years of official investigations. If the present approach to investigations continues, such lack of progress could go on indefinitely, or until some scientific body, finally getting frustrated, states "no evidence has been found to prove the existence of UFOs as being other than man-made objects or known natural phenomena, therefore they do not exist". Nevertheless, the UFOs will probably still be there. All attemps so far to ignore them in the hope they would go away, have failed.

7. To fend off the suggestion that I may be an individual with views shared by no one else, particularly by no one with a high status in the scientific field, I shall quote only four eminent scientists (I could quote others):

(a) Dr. James E. McDonald, Senior Physicists, Institute of atmospheric Physics, and Professor, Department of Meteorology, University of Arizona:

"It has become my conviction that the problem of the unidentified flying objects, is, indeed, the greatest scientific problem of our time."[1]

He stated further:

"The possibility that the Earth might be under surveillance by some high civilization in command of a technology far beyond ours must not be overlooked."[2]

(b) Dr. J. Allen Hynek, Professor of Astronomy, Northwestern University, and Scientific Consultant on UFOs to the U. S. Air Force:

"Enough questions exist on UFOs that serious scientific study is called for."[3]

(c) Dr. Felix Zigel of the Moscow Aviation Institute, and a top-ranking member of the Soviet Commission for investigating UFOs.

"The possibility that UFOs are from another planet merits serious consideration." Dr. Zigel released recent sightings of giant UFOs made from the Russian Astronomical observatory at Kazan, which astronomers said were crescent-shaped and they estimated them to be 1600 feet in diameter.[4]

He also stated:

"We must work calmly and thoroughly, employing all the means of modern science. The UFO phenomenon is a challenge to mankind. It is the duty of scientists to take up this challenge to disclose the nature of the UFO, and to establish the scientific truth."[5]

(d) Dr. James A. Harder, Associate Professor of Civil Engineering, University of California at Berkeley:

"In the UFO phenomena, we have demonstrations of scientific secrets we do not know ourselves. It would be a mistake, it seems to me, to ignore their existence."[6]

8. Statements of this nature are directly opposed to the views expressed by Sir Bernard Lovell who stated: "I am always surprised by the great amount of discussion which goes on in North America concerning these objects. They do not concern science, but science fiction. Scientists have been able to explain every UFO they investigated. Any suggestion that UFOs are visitors from outer space is nonsense."[7]

9. Clearly, Sir Bernard does not have the complete backing of the scientific fraternity.

10. It is because I am convinced that the solving of this mystery could be of immense importance to the human race, and that a new approach to

investigating the phenomena is urgently needed, that I submit this brief.

THE REALITY OF UFOs

11. The question which is probably the most frequently asked is -- do UFOs really exist? Certainly they exist. A steadily increasing number of thinking people are becoming aware of the fact that there is much more to the UFO mystery than we are led to believe by those who are in a position to influence public opinion, which includes not only scientists, but the press, and governments as well. There are too many people in these groups who will go along with a UFO story as long as the bounds of imagination are not stretched beyond what they consider to be a tolerable limit. In the case of scientists, the tolerable limit is usually the present laws of physics. In the case of governments, they accept what Science says is so, or is not so. A tendency of the press is to embellish UFO stories with amusing headlines and personal comments of the reporter in an attempt to cast an aura of illusion on the whole business. Thousands of responsible citizens know UFOs exist as they saw them and no amount of whitewash and ridicule can change this. It merely shuts them up. A 1966 Gallup Poll revealed that 5,000,000 American adults have seen UFOs. Of those, over 99.5% failed to report the phenomena to the U.S. Air Force.

12. It is sometimes stated how strange it is that scientists never see UFOs. Let me assure you that some have.[8] Those who do witness unusual phenomena frequently display a consciousness of colleague criticism that dampens any spirit of inquiry. A UFO researcher in the U.S.A. once sent a questionnaire to one hundred astronomers, in which he asked if they had ever seen a UFO through an astronomical telescope. All replied in the negative. Strangely enough, the same astronomers replied also to a further question that they had never seen an airliner through a telescope either.

13. A recent case in Canada (in October, 1967) occurred off the Coast of Nova Scotia, when a UFO was seen to settle down from the sky and disappear into the sea. This object was real enough for the Navy to conduct an underwater search for several days. The failure to locate it does not mean the object never existed. This sort of thing simply proves the objects are elusive, not illusions.

14. A majority of recorded sightings are made by reliable, stable and educated citizens and the most articulate reports come from obviously intelligent observers.[9] These include airline and military pilots, air traffic controllers, radar operators, police and many others. These are people whose jobs depend upon what they see. There are, indeed, photographs verified by top photo laboratories as being authentic, which prove the existence of physical objects. Radar has confirmed visual sightings; Electromagnetic effects have occurred at the time of sightings and in the immediate vicinity; various physiological effects have often been registered, and ground effects of varying nature such as burns, holes in the ground, flattened grass, etc. have occurred. The intensity of radiation measurements has often been found to be much higher after the departure of a UFO, and various effects on foliage have resulted. Several patterns in their behaviour have been recognized.

15. All these forms of evidence testify to the simple fact that UFOs do exist. There is no longer any question about this. One substantial sighting alone, properly verified, proves that UFOs exist. Ten thousand sightings don't prove it any further. As William James wisely said, it takes only one white crow to prove that all crows are <u>not</u> black. It is not necessary to possess a UFO and examine it in a scientific laboratory to prove its existence. We all know the sun exists, but man has never touched it, and never will. We measure its effects, visually and in many other ways. Science is

asking an already-answered question. The real question that requires an answer at this stage is -- what are they? This is the $64 question.

16. To answer this question, the most acceptable scientific thing to do would be to make observations and then propose a hypothesis which is capable of explaining the observed facts -- <u>all</u> the observed facts. Then continued observations must be made to determine whether the observed facts are still consistent with the hypothesis. If so, the hypothesis remains a valid one. If not, a more suitable hypothesis must be found. It was Sir James Jeans who said:

"One phenomenon is enough to disprove a hypothesis but a million million do not suffice to prove it."

17. Hypotheses have been proposed by some scientists in an effort to explain UFOs (examples cited earlier) but although some sightings of strange phenomena can indeed by explained by each of these, there still remains an <u>unknown</u> percentage which <u>cannot</u> be so explained. Those hypotheses, therefore, are not valid as explanations of these remaining unidentified objects.

18. To quote Dr. McDonald again:

"......my position is that UFOs are entirely real and we do not know what they are because we have laughed them out of Court. The possibility that these are extraterrestrial devices, that we are dealing with surveillance from some advanced technology, is a possibility I take very seriously."[10]

AN ACCEPTABLE HYPOTHESIS

19. A hypothesis has been proposed by many laymen, and a small number of open-minded thinking scientists now accept it as a valid one, and that is that at least some UFOs are intelligently-controlled interplanetary space vehicles. This is known in some scientific circles as the "ETI hypothesis" (extra-terrestrial intelligence). All the observational evidence pertaining

to sightings of true UFOs supports this hypothesis as long as we do not limit our thinking by restricting it to only known physical laws.

20. An outstanding example of a scientist who openly accepts this hypothesis is Dr. James E. McDonald of the University of Arizona, whom I quoted earlier (para. 18). He has presented briefs on the subject to important groups in the U.S.A. and has expressed utter dismay at the lack of interest in this matter which his colleagues in the scientific fraternity display. An AP report from Washington on July 30, 1968, revealed that he informed the U.S. House of Representatives Science & Astronautics Committee the previous day that the massive power black-out of 1965, and other power failures, may be related to UFOs, due to the numerous instances of these objects hovering near power plants, particularly at the moment of power interruptions.[11] Here we have another pattern being developed, which should be watched closely.

21. Hundreds of cases are on record where automobile engines have stopped upon the near approach of a UFO. Airliners cramped with scores of passengers have been paced at close range and some near collisions have resulted. Human beings have received burns from being too close to these objects. Medical records testify to these burns. Radio & T.V. are frequently cut off during close approaches of UFOs. Much evidence exists that UFOs have in fact landed on numerous occasions, and indentations have been left in the soil, grass flattened, and foliage broken or burned. High ranking officers in armed services around the world have reported encounters with these objects.

22. Not one known fact has disproved that interplanetary hypothesis despite current acceptance of so-called known "physical laws". Our present laws of physics have never been proved. They simply have not yet been disproved. They

are valid only so long as all observed phenomena conform to these laws. Using Sir James Jeans as my guide, it is apparent that one phenomenon can disprove something. If therefore, we discover a phenomenon which does not obey the laws of physics, we must not ignore it, in hopes it will go away (as Science has been doing with UFOs for twenty years) -- we must take another look at our physical laws.

23. The tendency, unfortunately, is for Science to be dogmatic and insist that nothing can exist which disobeys physical laws. Yet, Science, paradoxically, readily admits there is much we do not yet understand about our physical universe. If we discover something new today, it proves very simply that there was something we didn't know yesterday. As new discoveries are being made daily, there is obviously a great deal we don't know. Perhaps we are still ignorant of much about us because our physical laws are too restrictive and limited. As long as Science insists on compliance with man-made laws, we may never come to understand the true physical laws established during the birth and formation of this vast universe. What Science calls laws are, more correctly, what Science <u>considers</u> to be laws based on observations to date. It is a fact, which scientists do not like to have discussed publicly, that some physical laws have been violated in the recent past, and these laws "fell", to use scientific jargon. Three examples which I used in my book are, the laws of conservation of parity, charge conjugation invariance, and time reversal invariance, all of which "fell" within a seven-year period ending in 1964.[12]

24. Scientists believed in these laws because they lacked certain knowledge. They too readily believe that because all evidence indicates a certain thing to be so, all evidence in the future will support this.

25. The fall of parity in 1957 shook the scientific community severely -- possibly more than it had ever been shaken before. My point is simple -- it

can happen again. It did happen again.

26. An attitude I am frequently faced with in my discussions on UFO research is that laws of physics are supposedly sacred, and no hypothesis could possibly be acceptable if any part of it requires a contravention of physical laws. This attitude is inherent in our educational system and it is no wonder scientists have this attitude. They are educated to believe these laws are sacred. The fact that several of these same laws have recently fallen does not seem to cause them to be more watchful and ready to accept the possibility of more laws falling. These tremendously important events should have opened scientists' minds to any possibility, but apparently our institutionalized educational system has so indoctrinated them that past failures are soon forgotten. The dogma lingers on.

27. A question frequently posed is -- what proof do we have four our hypothesis? When a lack of proof is demonstrated, the questioner immediately rejects the hypothesis. This is not scientific. The proof can yet come. Dr. Herbert Friedman, professor of physics at the University of Maryland, stated that the "hypothetical neutron star is a purely theoretical concept and no evidence for its existence has ever been obtained."[13]

28. Let met state at this point that I am quite familiar with the standard reasons as to why the validity of this interplanetary hypothesis seems very remote. For example, our solar system does not appear to contain any planets suitable for life as we know it. But why must any aliem life, even superior to us, necessarily be as we know it? Dr. S.A. Bowhill of the University of Illinois tells us that the chemistry of our upper atmosphere (above 164,000 ft.) is little understood, despite the many rocket probes we launch.[14] So, if we know so little about our own upper atmosphere, it is fairly certain that we know even less about that of other planets, and far less yet about the

lower atmospheres of other planets. Also, papers have been written on the great difficulties we should expect in interstellar travel, but these are all based upon present-day scientific knowledge (existing physical laws) and technology. They are also based upon the "foreseeable" future, and Edward Purcell of Harvard is an example of one who has tried to demolish such hopes in a devastating manner.[15] To say that UFOs cannot be space ships because of physical limitations is no argument. It is like saying the Egyptians could not have built the pyramids. Even though engineers today admit they cannot duplicate them, they were built. If extraterrestrial races are so highly advanced over us, and be capable of feats so advanced that we are not yet able to foresee them because our scientific foresight is based entirely on known physical laws. It was Dr. Clyde Tombaugh, discoverer of the planet Pluto, who said:

"It is absolutely impossible for us on earth, with a technology barely a couple of centuries old, to visualize a technology 50,000 years ahead of ours. They would have discovered power sources, laws of physics, chemistry and medicine which in our present state, are simply impossible for us to imagine."[16]

By admitting the possibility of yet unknown laws, the shackles of our present thinking are immediately loosened.

29. UFO witnesses among the general public are accused by scientists of jumping to the unwarranted conclusion that their sightings were of space vehicles or the so-called "flying saucers". However, apart from a few "cultists", the public does not react this way to sightings. The normal first reaction is that they saw an airplane, a balloon, a satellite, a flashing light on an emergency vehicle, or some such conventional object. Only when the witness realizes, after more careful observation, that there was action or performance

in a manner which readily ruled out such simple explanations does he go further in his hypotheses. The space ship hypothesis is usually his last. This tendency to take a simple guess first, and then upgrade it when the simple ones are ruled out is characteristic of witnesses and is what Dr. Hynek refers to as "escalation of hypotheses". Witnesses do in fact use scientific method (instinctively, if you like) in arriving at their space ship hypothesis. It is only when they have ruled out, in their own minds, conventional explanations, that they turn to the space ship explanation.

30. Professor Frank B. Salisbury, professor of exobiology at Colorado State University published an article in Science in which he stated that we must concern ourselves with the possibility of technological civilization on Mars. Certain peculiarities of Mars and its moons, Phobos and Deimos, he wrote, "are most easily understood on the assumption that they are the product of intelligent beings." Professor Salisbury's views are shared by Dr. Carl Sagan of Harvard University and the Smithsonian Astrophysical Observatory.[17] Similarly, attributes of UFOs are most easily understood on the assumption that they also are products of intelligent beings.

31. The recognition and acceptance of the hypothesis I have been discussing, as a valid one, is the first giant step towards the ultimate solution of this mystery. Indeed, more than one hypothesis can be used at the same time, but as long as this one is ignored, no progress is made. Twenty-one years of official investigations support this statement.

PAST & PRESENT INVESTIGATIONS AND THEIR LIMITATIONS

32. In the U.S.A., the U.S. Air Force has been the official investigating body since December 30, 1947. Their program is currently labelled "PROJECT BLUEBOOK", and was formerly identified as PROJECT SIGN and PROJECT GRUDGE.

Little has come from this project of a constructive nature. Periodically, a report is issued to the public on results of investigations to date, and these results are tabulated showing the percentage of sightings identified, after investigation, as specific man-made objects or natural phenomena. The percentage remaining in the unidentified category fluctuates in the general areas of 2 or 3 percent. It happens that only about 12,000 UFO sightings have been reported through official channels to the U.S. Air Force in twenty years, yet 5,000,000 Americans have seen UFOs according to a 1966 Gallup Poll, as stated earlier. Further, certain North American space surveillance radar systems are not programmed to record "anomalous observational phenomena". In the words of Dr. Robert M.L. Baker, in his testimony before the Committee on Science and Astronautics, U.S. House of Representatives, July 29, 1968:

"Apparently what is now happening is that the Air Force surveillance radar is throwing away the data that is of relevance for this inquiry. In other words, if it sees something that is not on a ballistic trajectory or not in orbit, it ignores it, it throws it in the garbage. Well, that garbage is just the area of our interest."[18]

33. By the USAF's own admission, their figures do not include reports by letter directly from civilians, at least in some cases. For example, for the period June to September, 1952, 800 such reports were omitted from their statistics released to the public.[19] It is the BLUEBOOK Reports (sample attached as Annex "A") which probably have the greatest impact on public and official thinking in this regard. For example, it has been made clear to me by the Department of National Defence that that Department has been considerably influenced by these reports. It is of particular interest to note that the U.S. Air Force Scientific Advisory Board Ad Hoc Committee to

Review Project BLUEBOOK stated at a hearing by the Committee on Armed Services of the House of Representatives on April 5, 1966, that

"some of the case records that the committee looked at that were listed as "identified" were sightings where the evidence collected was too meagre or too indefinite to permit positive listing in the identified category.[20]"

34. It is also of significance that the USAF regularly claims that it "does not withhold or censor any information pertaining to this unclassified program", yet the PROJECT GRUDGE and BLUEBOOK reports No. 1 to No. 12 covering a period from 1951 to 1953 were in fact classified and were only released to the public in 1968 after "persuasion" by the Foreign Operations and Government Information Sub-Committee of the House Committee on Government Operations. These reports contain valuable data as well as important background information on research techniques, and yet they were withheld from the public for fifteen years.

35. The foregoing are two examples which serve to prove that the public in general, and official bodies which place faith in PROJECT BLUEBOOK, are not being correctly informed of all the facts.

Dr. James E. McDonald stated:

"Scientists throughout the world have tended to ignore the UFOs as if they were just so much nonsense. From talking to fellow scientists here and abroad, I have seen that most of them have believed that Air Force Project Bluebook was really studying the UFOs with scientific competence. The trouble was that almost none of these scientists took time off to check for themselves. I did. What I have found is nothing short of alarming. Bluebook and its consultants have simply swept under a rug of ridicule and innuendo thousands of sightings from credible witnesses, sightings of objects that are neither swamp gas nor secret test devices, nor fireballs nor ball lightning."[21]

36. On November 1, 1966, the USAF awarded a contract to the University of Colorado for the conduct of a full and supposedly objective scientific inquiry into the matter of UFOs. The report of this committee was made public early in January this year. This particular project experienced serious internal disruption which cast a cloud of suspicion over the manner in which it was directed.[22] This internal strife resulted in the dismissal of two key scientists of the project. One of these, Norman E. Levine "maintains that a lot of evidence points toward the extraterrestrial origin of UFOs, and says that, "If you ignore the extraterrestrial hypothesis, you are ignoring the most significant part of the problem."[23]

37. Let us not be misled by the report of the Condon Committee at the University of Colorado. I predicted in 1967 that the question of what UFOs really are would still remain open upon the publication of this report, as it was highly unlikely that the Condon Committee could present proof that UFOs are space vehicles as Condon's approach has tended to ridicule such a hypothesis and he made public statements to this effect, during the course of the investigation. Further, sighting reports evaluated, many of which have been available to the public through one means or another, cannot disprove such a hypothesis. It is particularly noteworthy that Condon did not prove that UFOs are something else, and name it, so he was forced to leave the problem unsolved. Many sightings remain unidentified, so nothing has really changed as a result of the Condon report. He has generalized and stated that UFOs are many different things, but has left many well-documented cases unidentified. Indeed, the report was not unanimous by all the committee members, but Condon eliminated this problem by terminating the services of the dissenters. A shrewd move, to say the least. One of the dissenting scientists has just published a book to bring to official and public notice

the discrepancies of the Condon investigation and to point out that much significant evidence was overlooked or rejected.[24]

38. I therefore strongly urge that caution be used in the interpretation of the Condon Report. Let us not be lulled into a false impression that Condon has proved that UFOs are not space vehicles as such proof has not been presented. In fact he did not make this claim. Let us not be fooled into thinking the whole matter is finished, as the question in fact remains open. Its remaining open proved only one thing -- that the Committee did not solve the problem. We are left where we were <u>twenty-one years ago</u> and my contention that scientific investigations to date have been inadequate to the task has been supported.

39. Many questions can be asked now that the Condon Report has been released. A few of these questions, with answers contained in the Report are listed separately as Annex "B" to this brief. These answers are very enlightening as to the real findings of the study.

40. In Canada, even less progress has been made to date. In the early 1950s, a study was conducted by an engineer in the Department of Transport. This was primarily a spare time project on the part of the engineer-in-charge, Mr. Wilbert B. Smith, but the Broadcast and Measurements Section of the Telecommunications Division was given the directive to go ahead with this work with whatever assistance could be obtained informally from outside sources such as Defence Research Board and National Research Council. This study was named PROJECT MAGNET. In the final paragraph of his report, Mr. Smith stated:

"It appears then, that we are faced with a substantial probability of the real existence of extra-terrestrial vehicles, regardless of whether or not they fit into our scheme of things. Such vehicles of necessity must use a technology considerably in advance of what we have. It is therefore submitted that the next step in this investigation should be a substantial effort towards the acquisition of as much as possible of this technology, which would without doubt be of great value to us."[25]

41. Since then, little has been done in Canada except to investigate a minor percentage of those reports reaching the government officially. There has been little or no policy direction concerning the study of this matter in Canada, and responsibility has been bounced from one department to another, with individual departments displaying interest only in so far as each department has a particular area of activity. I support this statement by the fact that my personal correspondence with high levels of government, including the former Prime Minister, always resulted in departmental replies clearly showing interest was limited to only one aspect of the problem. For example, Department of Mines and Technical Surveys (as it was known at that time) expressed a view related only to the astronomical aspect. My opinion about the interest of the Department of National Defence was confirmed when it was made clear to me recently that their prime interest was in whether any threat to national security was involved. It having been established that no such threat exists, D.N.D. then passed the task to the National Research Council, which now carries the ball. No public funds are provided specifically for this purpose and therefore any investigations are limited to what can be accomplished by using funds allotted basically for other purposes, and no staff is allowed for. This investigating responsibility is carried by Dr. Peter M. Millman, Head, Upper Atmosphere Research Section. No matter how capable the project chief may be, he cannot conduct any adequate, comprehensive and thorough investigation of the total problem without staff and without funds. NRC cannot even analyze all sightings in Canada over the past twenty years in search of patterns, without people to do the work. They also lack the files from which to work. It is worthy of note, however, that N.R.C. is apparently continuing its very limited activity in this field despite the Condon Report. This, at least, is an indication of clear thinking on the part of someone.

42. At no time, evidently, has there been any one office with an overall interest in all the many aspects of the problem, with the objective of solving the total problem, not simply parts of it, or individual sightings, which leaves the overall matter still a mystery.

43. Late in 1967, considerable publicity was attached to an announcement by the University of Toronto, that a UFO study was being commenced, under the direction of Dr. Gordon Patterson of the Institute for Aerospace Studies. The public has not been well informed of activity of this group, other than an opening forum which conveyed the impression of being a mere attention-getter. In October, 1968, the press reported that this study was on the verge of collapse "owing to a lack of something to investigate, and if some good flying saucer cases don't soon crop up the Institute will have little chance of receiving a National Research Council grant for more costly and intensive study."[26]

44. We have, here, the same old problem. A new study gets under way and they start out only at that point in time, ignoring the many thousands of cases already documented, which could be studied in a search for patterns. The new cases arising could be added to the existing data -- they should not comprise the sole data. By ignoring the past records, twenty years of research by others is being overlooked. Do the people of the Aerospace Institute consider themselves the only competent investigators so that they may ignore the work of others? Surely this is not the way to conduct scientific research. Also, I suggest that the sightings reported to the Institute comprise only a small percentage of total observations in Canada during the period, partly due to the fact that few people are aware of the existence of this project. Even those who are aware seem unable to get information from them as to their activities. I have tried and failed.

45. The Science Council of Canada appears to be either completely disinterested in this vital scientific problem, or else it is unwilling to communicate with the public concerning it. I wrote to the Council concerning the matter of UFOs on September 7, 1968 and am still awaiting a reply, despite having hastened a reply by both letter and telephone. Also, the subject of UFOs was conspicuous by its absence from the report of the Science Council, titled A SPACE PROGRAM FOR CANADA, dated July, 1967.

46. Even our Members of Parliament are unable to obtain satisfactory answers to their questions in the House of Commons. Questions have been asked frequently over the past few years and my files contain the pertinent extracts from Hansard. The most glaring example of a brush-off to such a legitimate question by an elected representative of the Canadian public contains the clear suggestion that possible future sightings around Christmas time might be attributed to Santa and his reindeer.[27]

47. The situation is much the same throughout the world, except for Russia where an intensive study has recently been instituted by the Academy of Science and is titled "The UFO Section of the All-Union Cosmonautics Committee" but more commonly known as "The Russian Commission".[28] Dr. Felix Zigel, whom I quoted earlier, is a top-ranking member of this Commission.

48. One of the main difficulties in solving the UFO Mystery is the limited approach to the problem which science has so far taken. There are many limitations to science, and scientists themselves have limitations, many of which I have outlined in some detail in Chapter IX of my book. Scientists themselves have acknowledged these limitations and therefore are not in a position to dispute them. Because of these limitations, many aspects of the UFO problem have not been considered by scientific inquiries. There has been

a definite tendency to limit the study to a few fields, primarily astronomy, physics, psychology and meteorology, and in general, each scientist interprets UFO phenomena in terms of his own specialized knowledge and experience.

49. The field is much broader than this, however, and a comprehensive view of the entire problem cannot be acquired without the inclusion of many other fields of study at the same time and with consideration given to the interrelationships and overlaps among all fields. Some other subjects which are a definite part of the overall study are: aeronautics, astronautics, cosmology, evolution, biology and exobiology, history, philosophy, and scientific method (methodology). No UFO Study can be completely objective and thorough without the inclusion of all these fields, as I clearly show in my book.

50. With respect to scientific method, I can illustrate the inconsistencies that arise by the following example:

"Until about four centuries ago, it was thought that the sun revolved around the earth, and this was a firm belief because of the sun's apparent movement through the sky. A very satisfactory system of celestial mechanics was developed on this assumption which permitted highly successful prediction of heavenly phenomena. As there is no motion felt of the earth through space, our sixteenth century forebears can hardly be blamed for their views. However, let it be borne in mind that no physical experiment has ever proved that the earth actually is in motion."[29]

51. That is a good example of the inconsistency of scientists -- they tell us that scientific method must be employed, that unless a hypothesis can be tested, it cannot be proved to be true. The foregoing example, it seems, cannot be proved by any experiments. Everyone agrees today that they hypothesis is true, and no one argues it. But the fact remains that it has not

been proved and is evidently not capable of being tested. If scientists can accept one hypothesis as being true without being able to prove it, why not accept another? At present, we do not understand the conditions under which UFOs appear, therefore a desire that ufology duplicate the methods of other sciences is unreasonable.

52. My book contains many examples which clearly demonstrate that Science, as such, has been inadequate to the task of solving the UFO problem, under present conditions within Science itself.

53. There exists in modern science what I choose to refer to as the 'orthodox barrier'. This barrier is one which excludes unorthodox thought, particularly when manifested in the printed word. To be recognized, one must generally conform to orthodox teachings, orthodox theories and orthodox methods. To penetrate this barrier is a formidable task. The sound barrier, the heat barrier and the escape-from-earth barrier represented physical limitations, all of which have been overcome by science and technology. But the orthodox barrier is a mental barrier which requires only an opening of men's minds to release preconceived ideas which result in narrow thinking.

54. Dr. David Green gives his own case as an example of being unable to "reach the establishment", or as I call it, penetrate the orthodox barrier. In Scientific Research he describes his work at the Institute for Enzyme Research at the University of Wisconsin where his team developed a new concept of membrane structure and function in mitochondria -- a concept that will revolutionize thought on the whole subject of how chemical energy can actually perform physical work in the cell. "But the scientific establishment has ignored us", he states, "It is amazing how difficult it is to reach the establishment. After all, I, too, have position and authority -- still it is impossible. I have been fighting them for years. I could write a book

about it", he says.[30] I hope he does.

55. It appears to me that so long as a scientist is adding bricks to what has already been built, his work is recognized. But if his new construction requires the tearing down of what was built before, he is ignored. He cannot then penetrate the barrier. This indicates the unwillingness of scientists to admit that what has already been accomplished could be wrong.

56. A change in attitude is required, and when this is brought about, the orthodox barrier need not be penetrated -- it will collapse from within.

PHILOSOPHY OF THE PRESENCE OF UFOs

57. Many people reject, on philosophical grounds, the possibility of UFOs being machines controlled by visiting alien races, so we must examine this area of the problem also.

58. Using our present hypothesis, as UFOs have been around for so long, it is frequently stated that if UFOs were visitors from outer space, they would no doubt have landed and made public and official contact with us long before now. But we must consider possible motives for such action, or lack of it. If such a race, or races, is visiting our planet, it may not be their intention to make direct contact with us. A race so highly evolved as they could be, may simply be observing us, as scientists observe the behaviour of animals and insects. It is the same old failing we humans have -- extraterrestrial life must be life as <u>we know it</u>; physical laws must be only those laws which <u>we</u> have discovered; alien races must travel through space the way <u>we</u> would travel through space; and worst of all, they must <u>think</u> the way we think. I can only add, that if they do, then God help them.

59. They could be simply observing us on a long-term basis to determine our progress scientifically and morally. We could be considered a source of

danger to near-by planets, through the transmission of disease germs and by our detonation of nuclear bombs. To them, we may be as close as next door neighbours, but we would be uneasy if our neighbour on Eart detonated dynamite on his property.

60. After such long and careful observation of Earth, such a race would know a great deal about us and our way of life and our scientific achievements. Because of this, I am sure they would be careful not to be caught off guard should we visit them eventually.

61. It is thoughts of this nature that convince me that the rejection of our current hypothesis on grounds of the lack of answers to questions such as why don't they land, why don't they contact us etc., is a major error in our thinking. Our way of doing things must not be taken as a standard for others, particularly those who may be far more advanced in all ways. It is therefore unreasonable, in my view, to reject the interplanetary hypothesis on philosophical grounds.

A POLICY DECISION IS NEEDED

62. It is well for us to bear in mind that Science, by its very nature, is forever prevented from solving some problems. Although science assists us in controlling nature, it is unable to guide us in determining in what direction we should exercise such control. With respect to the external world, science is our guide to a means to an end, but it has no part in determining the ends to which means should be directed.

63. It is in this regard that I state that the decision as to whether a thorough, complete and objective study of the UFO enigma is to be carried out is a governmental decision and should be based upon the possible benefits or otherwise, to humanity, which might accrue from the solving of the mystery.

If, for instance, UFOs are interplanetary space ships, thus proving that other worlds are inhabited by beings superiod, in at least some ways, to us on Earth, with a science and technology far in advance of ours, there are benefits to the human race here if we can also require this knowledge. Clearly, a decision to embark upon a program to solve this mystery is not solely a scientific decision, and therefore, conversely, a decision not to embark upon such a program should not be based upon scientific advice alone. There are moral, ethical, economic, and philosophical considerations also, which are at least equally as important as the scientific ones, as these represent end results to be gained, in addition to scientific and technological advancement. Questions are also raised regarding the future, and past, of the human race on Earth. Dr. Carl Sagan told a committee of the U.S. House of Representatives that "a bonafide example of extraterrestrial life even in a very simple form would revolutionize biology... it would have both practical and fundamental scientific benefits."[31]

64. Data collected on erratically-moving phenomena (including the rapid determination of any landings or impacts) would add significantly to the coverage and analyses of meteorites, as well as contributing to an understanding of atmospheric physics, one of the great mysteries of which is ball lightning.

65. Also, although there is no current basis for concluding that hostility and grave hazard lie behind the UFO mystery, we cannot be entirely sure of that. A risk we are taking is the possibility that UFOs may be mistaken for hostile devices of another nation on Earth which might accidentally trigger a nuclear war.

66. For all of these reasons greatly expanded scientific and public attention to the UFO problem is urgently needed. I suggest that lack of governmental action in the past has been due, primarily, to negative scientific favour for

such a program. To date, it seems that the Science Council of Canada has ignored the UFO problem, which in effect means the Council is ignoring the benefits which could accrue from solving the mystery.

67. Humanitarian considerations should be the real objective of all scientific advance, otherwise there is no point to scientific inquiry. Knowledge for its own sake is useless -- it must be put to use for mankind's benefit. We surely want to advance the human race, so all research should be directed with this aim in mind. If societies on other planets are far advanced over us, we can learn from them, thus saving ourselves a great deal of effort and money.

68. There was a program in the U.S.A. to seek out life on other planets and I emphasize <u>on</u> other planets. This method was by means of radio. But if such alien life is, perhaps, transporting itself to our own atmosphere, it would appear more logical to seek it out right here, in our own supposedly-familiar environment than tens of millions of miles away. The chance of finding alien life here (if it is visiting us) seems to be infinitely greater.

69. If UFOs are some unknown natural atmospheric phenomena then we are not as familiar with our own environment as we think, so we should be trying harder to learn more about it. This could explain the inability of our meteorological experts to give us more accurate weather forecasts. It is a fact that several aircraft have crashed while chasing UFOs and their crews have been killed. Many near-collisions in the air are on record. As stated before, UFOs have been seen over the location of huge power blackouts. After all these years is it not time that science had an answer for us? What tragedies can we expect in future while science in general continues to ignore this situation?

70. As an argument against the existence of visiting interplanetary vehicles I have been told by scientists that if life exists on other planets, any communication with such civilizations is more likely to begin by radio techniques than by space vehicles. In my opinion, there are at least two things wrong with this view. First, it assumes that because this may be more likely, the possibility of space vehicle communication may be ignored. Secondly, it overlooks the possibility that attemps to communicate with us by radio may have been started thousands of years ago, even before space vehicles may have begun visiting us. Because we have not been aware of radio messages to us does not by any means prove that such attemps have not been made. Certainly, until just a few years ago, we weren't even listening!

71. It is now known that Russian scientists are engaged in a UFO inquiry, as referred to earlier. This is of particular significance in that western nations could be placed in a most embarrassing position if Russia should be the first to discover that UFOs are indeed intelligently-controlled interplanetary space vehicles, and announces this, along with its evidence, to the entire world. Russia could, indeed, become the first nation to make contact with such a race. Russia might acquire this knowledge and not share it with the remainder of the world, but use it to further her own ends alone. This possibility in itself is sufficient justification for all nations to work together to solve the mystery and share the benefits equally. As Dr. James McDonald stated:

"It would be amusing if it should turn out that Russian scientists are the ones who finally convince the world that twenty years of assurances by the United States Air Force were completely unjustified."[32]

72. I have attempted to show to your that the UFO phenomenon is of far wider scope than is generally recognized. It embraces much more than just a

few fields of science and overflows into areas not yet within the bounds of science. The scientists themselves, generally speaking, are limited by their own fields of specialization. Whole aspects of the problem are overlooked, if humanitarian considerations are omitted. And these are omitted in purely scientific studies. Unless all the many aspects of the problem are considered as a part of the total problem, a distorted view of the overall picture is bound to be the result. This has proved to be so.

73. This is the age of the specialist, the expert, the professional, and it has become increasingly the age of the jealously-guarded vested interests in all spheres of activity. The average layman has been made to feel inferior, by degrees, credentials and authorities in all professional areas and the experts have encouraged this awe of authority as it boosts their status in the public eye.

74. The average citizen lacks the courage to openly disagree with the "experts" because of this air of authority which they carry. The UFO phenomenon has been left in the care of the supposed "experts" for twenty years and they have not reached a solution to it. It is time for a broader view to be taken of this great mystery, unrestricted by the narrow fields of specialization of particular individuals.

75. It was Dr. Rene Dubos, of the Rockefeller Institute for Medical Research who stated:

"A society that blindly accepts the decisions of experts is a sick society. The time has come when we must produce, alongside specialists another class of scholars and citizens who have broad familiarity with the facts, methods and objectives of science, and thus are capable of making judgments about scientific policies."[33]

76. The public is growing impatient and does not want another twenty years of UFO confusion. They want to know if there really is something to this whole business -- and they are dissatisfied with answers handed out to them. The public in general may lack detailed knowledge of scientific matters but they have an uncanny way of distinguishing between an honest scientific approach and the method of ridicule. If ours is to be a "just society" then it is time for the people to be given all the facts. It is time for a top level recognition of the UFO phenomenon as a matter of extreme importance to the human race on this planet. This recognition must be followed up by a determination to discover for certain what UFOs really are.

77. In my opinion the hypothesis I have been discussing remains the only hypothesis which remains valid to explain <u>all</u> UFOs at this time. This hypothesis must be retained until proved wrong, or one is proposed which is better able to explain <u>all</u> the observed facts.

78. To test this hypothesis, we need a proper investigation, not limited as past and present inquiries have been. All the numerous areas of the matter which I identify in my book must be a part of such an investigation. Sightings need to be properly and thoroughly reported and co-ordinated. A move is underway in the U.S.A. to get thousands of ham radio operators to transmit sighting reports immediately so that others may watch for these objects as they are reported travelling in certain directions so that plots of their movements may be made, to establish patterns of activity.[34] Certain patterns have already been established in some parts of the world, and organizing in this manner could be very helpful in collecting the necessary data for computer processing. Patterns are needed in the scientific investigation

of UFOs. Will Oursler stated:

"A case by case acceptance or refutation of individual sightings is of little value. We need to explore the possible underlying meanings of these sightings to search for some pattern that might provide a reasonable hypothesis for as yet unexplored avenues of further examination."[35]

79. Some patterns already observed by private investigators, include observations along great circle routes, electromagnetic (EM) interference, physiological effects, the locality of terrestrial significance and colour changes, among others. There now appears to be evidence for a developing pattern which links UFOs to fault lines in the earth's crust. As seismologists know, it is here that many major earthquakes occur. If such a pattern is confirmed, this could be of considerable significance.

80. There are many things that need doing in the conduct of such an investigation. Detection of patterns is only one example.

81. As stated earlier, one substantial sighting, properly verified, proves that UFOs exist. 10,000 sightings don't prove it any further. But the 10,000 sightings might establish what they are, and this is the question that now requires a definite answer. The other question that must be answered in conjunction with that one is, what are they doing here? As these objects are busying themselves all over the world, they must be doing something. We need to know what that something is; what the purpose is behind their activities; what they are really doing that requires frequent landings in remote areas; what requires the widespread and primarily nocturnal activity.

82. As UFOs are a world-wide phenomenon, and the patterns are observed on a global basis, the mystery must be studied on a global basis in order to

establish full and complete patterns. This, of course, requires international co-operation, with a central co-ordination or "filter" centre. I suggest that the UN, as a detached, international organization is the ideal organization to do this. But before the UN would undertake such a task, it is to be expected, I would think, that individual nations show strong concern over the problem and demonstrate a desire to solve it by taking some positive action in that direction.

83. I therefore suggest that we in Canada awaken from our slumber and realize the importance of the matter and attempt to solve this mystery on a total basis, with a fully-objective study, not limited to narrow fields as in the past, and not restricted to an individual-sighting basis. The UFO presents a direct challenge to the physical and philosophical concepts developed by man over many years. The final analysis of our own existence could be dependent upon the sincerity with which we conduct this research. Scientists should accept as a challenge the opportunity to be a part of a formal inquiry into UFOs. Such an inquiry should include serious laymen researchers as well as scientists, as it is important that the two groups work together, rather than against each other. There are private researchers and organized groups in possession, collectively, of a vast amount of scientific and technical data, and detailed, fully-investigated sighting reports, far in excess of that possessed by governments, in my opinion. As so much valuable data is already in the hands of such non-official researchers, it would be a major error to ignore it. I have seen no evidence that either NRC or the University of Toronto have collected this data from other groups in order to conduct an adequate study. And let it not be forgetten that such data has been collected all over the world and the total accumulation is monumental.

84. The public has been confused by reported sightings made by reliable and trusted citizens on the one hand, and official refutations on the other.

Thousands of people feel that officialdom is not being honest with them and they want the answer as to what UFOs really are -- the right answer. This situation must be brought to an end so that all the known facts can be made available to the public. The UFO mystery is a matter of national and international importance and must be given the attention it deserves.

85. In order to accomplish this, I specifically recommend that Canada's science policy include serious and urgent consideration of the UFO enigma. Science cannot escape this phenomenon -- it is merely shying away from it in an effort to avoid it. This policy should include the determination to solve the mystery in concert with other nations, and set the example to other nations by establishing the first fully-objective, and open investigation, not shrouded in a cloak of secrecy, which will leave no stones unturned in getting to the heart of the matter. Funds must be provided in order that the right answer can be found. Our example to other nations should then provide the necessary encouragement for them to join us in this exciting quest so that eventually the UN can be the global co-ordinator for the study.

86. Science works with models. Models are constructed as a means of explaining phenomena. What is needed, is not a model UFO, but a new model of the universe. Existing accepted models of the universe are designed to explain the known facts of physics. We are aware that there is a great deal that we do not know. The unknown may or may not be explainable by existing models.

87. I suggest we need a model which would permit interstellar flight in brief time periods. It might have to include an entirely new concept of time, and probably also, new dimensions. It would require the postulation of new

theoretical concepts and, perhaps, the discarding of some existing laws on the grounds that they are too restrictive, and are valid only within known conditions.

88. To show that my suggestion may not be as "far out" as it may at first appear, I will quote Dr. T. Gold of Cornell University:

"Introspective understanding of the flow of time is basic to all our physics, and yet it is not clear how this idea of time is derived, or what status it ought to have in the description of the physical world."

"It may be that no very profound improvement in our understanding of time will ever take place, but it could also be that some new physical theory will be devised one day that depends on, or defines, a different concept of time."[36] Perhaps when we gain a true understanding of the real nature of time, we will find that lengthy periods are not involved in interstellar travel after all.

89. Let the construction of a new model of the universe be a challenge to science in Canada. This can be done as an intellectual exercise without the expenditure of large sums of money. As the Government is engaged in a cutback in spending, we might achieve great things at very little cost. We could achieve far more than with the Intense Neutron Generator which was to have cost us in the neighbourhood of $150,000,000 initially. Let us put our best scientific brains to work on theoretical cosmology without delay. The prestige to be enjoyed by Canada in the eyes of the world if we should be the ones to discover new physical laws, and to build a new model of the universe, would be tremendous, and we will then have grown to giant scientific stature.

21564—7½

REFERENCES

1. Lecture presented at a metting of the American Society of Newspaper Editors in Washington, D.C. on April 22, 1966, as published in "Unidentified Flying Objects -- Greatest Scientific Problem of our Times" by Pittsburg Sub-Committee of NICAP, 1967.
2. Hearings before the Committee on Science and Astronautics, U.S. House of Representatives, Ninetieth Congress, Second Session, July 29, 1968.
3. Electronic News, January 16, 1967.
4. The UFO Investigator, NICAP, Washington, D.C. Vol. IV, January-February, 1968.
5. Montreal Gazette, December 16, 1967.
6. Hearings before the Committee on Science and Astronautics, July 29, 1968, p. 119.
7. Ottawa Citizen, April 18, 1966.
8. Aids to Identification of Flying Objects, U.S. Government Printing Office, 1968, question 16, p. 30.
9. Ibid, Question 14, p. 30.
10. Hearings before the Committee on Science and Astronautics, July 29, 1968, p. 26.
11. Ottawa Citizen, July 31, 1968.
12. Bray, Arthur, Science, the Public and the UFO, Bray Book Service, Ottawa, 1967.
13. Friedman, Herbert, "The X-Ray Universe", Earth in Space, Voice of America Forum Lectures, 1968, p. 277.

14. Bowhill, S.A. "The Ionized Atmosphere", Earth in Space, Voice of America Forum Lectures, 1968, pp. 119-120.

15. Cameron, A.G.W., Interstellar Communication, W.A. Benjamin, New York, 1963, pp. 121 ff.

16. Tyler, Steven, Are the Invaders Coming? Tower Publications Inc., New York, 1968, p. 29.

17. Shklovski & Sagan, Intelligent Life in the Universe, Holden-Day, San Francisco, 1966, pp. 362-376.

18. Hearings before the Committee on Science and Astronautics, July 29, 1968, p. 190.

19. Project Bluebook Report No. 8.

20. Official Report, Unidentified Flying Objects, Hearing by Committee on Armed Forces of the House of Representatives, Eighty-Ninth Congress, Second Session, April 5, 1966, p. 5995.

21. McDonald, James A. "A Need for an International Study of UFOs", Flying Saucer Review, London, Vol. 14, No. 2, 1968, p. 11.

22. Science, Vol. 161, July 26, 1968, p. 339.

23. Scientific Research, May 13, 1968, p. 12.

24. Saunders, David and Harkins, R. Roger, UFOs? Yes! New American Library of Canada, 1968.

25. Smith, W.B., Project Magnet Report, 1953 or 1954.

26. Toronto Star, October 10, 1968.

27. Hansard, December 12, 1968, pp. 3900 and 3901.

28. UFO Investigator, Vol. IV, No. 5, March 1968, p. 6.

29. Barnett, Lincoln, The Universe and Dr. Einstein, Signet Books, New York, 1965, p. 73.

30. Bernhard, Robert "On the Road with David Green -- Campaigning for a New Theory", Scientific Research, May 13, 1968, p. 33.

31. Hearings before the Committee on Science and Astronautics, July 29, 1968.

32. McDonald, James E. "A Need for an International Study of UFOs", Flying Saucer Review, London, Vol. 14, No. 2, 1968, p. 11.

33. Science, November 4, 1966.

34. 73 Magazine, Vol. XLVII, No. 4, April 1968, p. 4.

35. Mechanical Engineering, July 1968, American Society of Mechanical Engineers, New York.

36. Gold, T. (Ed), The Nature of Time, Cornell University Press, 1967.

ANNEX "A"

PROJECT

BLUE BOOK

1 MARCH 1967

PROJECT BLUE BOOK

The United States Air Force has the responsibility under the Department of Defense for the investigation of unidentified flying objects (UFOs). The name of this program, which has been in operation since 1948, is Project Blue Book. It has been identified in the past as Project SIGN and Project GRUDGE.

Air Force interest in unidentified flying objects is related directly to the Air Force responsibility for the air defense of the United States. Procedures for conducting this program are established by Air Force Regulation 80-17.

The objectives of Project Blue Book are two-fold: first, to determine whether UFOs pose a threat to the security of the United States; and, second, to determine whether UFOs exhibit any unique scientific information or advanced technology which could contribute to scientific or technical research. In the course of accomplishing these objectives, Project Blue Book strives to identify and explain all UFO sightings reported to the Air Force.

HOW THE PROGRAM IS CONDUCTED

The program is conducted in three phases. The first phase includes receipt of UFO reports and initial investigation of the reports. The Air Force base nearest the location of a reported sighting is charged with the responsibility of investigating the sighting and forwarding the information to the Project Blue Book Office at Wright-Patterson Air Force Base, Ohio.

If the initial investigation does not reveal a positive identification or explanation, a second phase of more intensive analysis is conducted by the Project Blue Book Office. Each case is objectively and scientifically analyzed, and, if necessary, all of the scientific facilities available to the Air Force can be used to assist in arriving at an identification or explanation. All personnel associated with the investigation, analysis, and evaluation efforts of the project view each report with a scientific approach and an open mind.

The third phase of the program is dissemination of information concerning UFO sightings, evaluations, and statistics. This is accomplished by the Secretary of the Air Force, Office of Information.

The Air Force defines an unidentified flying object as any aerial object or phenomenon which the observer is unable to identify.

Reports of unfamiliar objects in the sky are submitted to the Air Force from many sources. These sources include military and civilian pilots, weather observers, amateur astronomers, business and professional men and women, and housewives, etc.

Frequently such objects as missiles, balloons, birds, kites, searchlights, aircraft navigation and anticollision beacons, jet engine exhaust, condensation trails, astronomical bodies and meteorological phenomena are mistakenly reported as unidentified flying objects.

The Air Force groups its evaluations of UFO reports under three general headings: (1) IDENTIFIED, (2) INSUFFICIENT DATA, and (3) UNIDENTIFIED.

IDENTIFIED reports are those for which sufficient specific information has been accumulated and evaluated to permit a positive identification or explanation of the object.

Reports categorized as INSUFFICIENT DATA are those for which one or more elements of information essential for evaluation are missing. Some examples are the omission of the duration of the sighting, date, time, location, position in the sky, weather conditions, and the manner of appearance or disappearance. If an element is missing and there is an indication that the sighting may be of a security, scientific, technical, or public interest value, the Project Blue Book Office conducts an additional investigation and every attempt is made to obtain the information necessary for identification. However, in some instances, essential information is requested from the observer and is never received; therefore, no further action can be taken.

The third and by far the smallest group of evaluations is categorized as UNIDENTIFIED. A sighting is considered unidentified when a report apparently contains all pertinent data necessary to suggest a valid hypothesis concerning the cause or explanation of the report but the description of the object or its motion cannot be correlated with any known object or phenomena.

TYPES OF UFO IDENTIFICATIONS AND EVALUATIONS

There are various types of UFO sightings. Most common are reports of astronomical sightings, which include bright stars, planets, comets, fireballs, meteors, auroral streamers, and other celestial bodies. When observed through haze, light fog, moving clouds, or other obscurations or unusual conditions, the planets, including Venus, Jupiter, and Mars have been reported as unidentified flying objects. Stellar mirages are also a source of reports.

Satellites are another major source of UFO reports. An increase in satellites reported as UFOs has come about because of two factors. The first is the increase of interest on the part of the public; the second is the increasing number of satellites in the skies. Positive knowledge of the location of all satellites at all times enables rapid identification of satellite sightings. Keeping track of man-made objects in orbit about the earth is the responsibility of the North American Air Defense Command Space Detection and Tracking System. This sophisticated electronic system gathers complex space traffic data instantly from tracking stations all over the world.

Other space surveillance activities include the use of ballistic tracking and large telescopic cameras. ECHO schedules are prepared by the NASA Goddard Space Flight Center at Greenbelt, Maryland, and schedules of the South/North equator crossings are prepared by the Smithsonian Institution at Cambridge, Massachusetts. From the data produced by these agencies, satellites mistakenly reported as UFOs can be quickly identified. Some of these are visible to the naked eye.

Aircraft account for another major source of UFO reports, particularly during adverse weather conditions. When observed at high altitudes and at some distance, aircraft can have appearances ranging from disc to rocket shapes due to the reflection of the sun on their bright surfaces. Vapor or condensation trails from jet aircraft will sometimes appear to glow fiery red or orange when reflecting sunlight. Afterburners from jet aircraft are often reported as UFOs since they can be seen from great distances when the aircraft cannot be seen.

The Project Blue Book Office has direct contact with all elements of the Air Force and the Federal Aviation Agency civil air control centers. All aerial refueling operations and special training flights can be checked immediately. Air traffic of commercial airlines and flights of military aircraft are checked with the nearest control center, enabling an immediate evaluation of aircraft mistakenly reported as UFOs. However, since many local flights are not carried, these flights are probable causes of some reports.

Balloons continue to be reported as UFOs. Several thousand balloons are released each day from military and civilian airports, weather stations, and research activities. There are several types of balloons - weather balloons, rawinsondes, radiosondes, and the large research balloons which have diameters up to 300 feet. At night, balloons carry running lights which cause an unusual appearance when observed. Reflection of the sun on balloons at dawn and sunset sometimes produce strange effects. This usually occurs when the balloon, because of its altitudes, is exposed to the sun. Large balloons can move at speeds of over 100 miles per hour when moving in high altitude jet windstreams. These balloons sometimes appear to be flattened on top. At other times, they appear to be saucer-shaped and to have lights mounted inside the bag itself due to the sun's rays reflecting through the material of the balloon. The Balloon Control Center at Holloman Air Force Base, New Mexico, maintains a plot on all Military Upper Air Research Balloons.

Another category of UFO evaluations labeled Other includes missiles, reflections, mirages, searchlights, birds, kites, spurious radar indications, hoaxes, fireworks, and flares.

Aircraft, satellites, balloons, and the like should NOT be reported since they do not fall within the definition of an unidentified flying object.

CONCLUSIONS

To date, the firm conclusions of Project Blue Book are: (1) no unidentified flying object reported, investigated, and evaluated by the Air Force has ever given any indication of threat to our national security; (2) there has been no evidence submitted to or discovered by the Air Force that sightings categorized as UNIDENTIFIED represent technological developments or principles beyond the range of present day scientific knowledge; and (3) there has been no evidence indicating that sightings categorized as UNIDENTIFIED are extraterrestrial vehicles.

The Air Force will continue to investigate all reports of unusual aerial phenomena over the United States. The services of qualified scientists and technicians will continue to be used to investigate and analyze these reports, and periodic reports on the subject will be made.

The Air Force takes no stand on whether or not extraterrestrial life could or does exist. Scientists believe that it is entirely possible that the universe contains life on planets other than our own. To date the existence of only one planet outside our solar system (Balmer's planet), has been demonstrated. No evidence yet exists that there is other life. The Air Force continues to extend an open invitation to anyone who feels that he possesses any evidence of extraterrestrial vehicles operating within the earth's near space envelope to submit his evidence for analysis. Initial contact for this purpose is through the following address:

PROJECT BLUE BOOK INFORMATION OFFICE
SAFOI
WASHINGTON, DC 20330

Anyone observing what he considers to be an unidentified flying object should report it to the nearest Air Force Base. Persons submitting a UFO report to the Air Force are free to discuss any aspect of the report with anyone. The Air Force does not seek to limit discussion on such reports and does not withhold or censor any information pertaining to this unclassified program.

The following items are for internal use only and are not available for distribution to the public. These concern internal management and procedures for forwarding UFO reports to the appropriate agency. The Air Force has no objection to persons visiting Air Force Bases and reading them:

1. Air Force Regulation 80-17

2. JANAP 146E

The Air Force has no films or photographs that indicate our planet has been visited by extraterrestrial vehicles. Photographs that have been submitted for evaluation in conjunction with UFO reports have undergone an intensive photographic analysis and none have provided evidence to substantiate the presence of extraterrestrial vehicles. Many widely circulated photographs have never been submitted to the Air Force for a comprehensive analysis. The Air Force returns all original photographs and negatives to the owner upon completion of the analysis.

The Air Force possesses only record copies, and thus does not have for distribution outdated reports on, Project SIGN, Project GRUDGE, or Blue Book Special Report No. 14. Copies can be made by the Project Blue Book Information Office at the expense of the requester at a rate of twenty (20) cents per page. Project Blue Book Special Report No. 14 contains 323 pages; Project SIGN, 44 pages; and Project GRUDGE, 405 pages. Each report must be reproduced in its entirety.

SUGGESTED READING MATERIAL

The non-military publications listed below should be obtained from the publishers, not the Air Force. Some may be found in local libraries. They deal with facts and theories about our solar system, the sun, planets, comets, meteorites, the universe, stars, constellations and galaxies; telescopes, the computation of time as it relates to astronomy, starmaps and charts, and the history of astronomy and information on optics and lights.

SKY & TELESCOPE, by Sky Publishing Corporation, Harvard College Observatory, Cambridge, Massachusetts 02138. Monthly Magazine, 60 cents per copy.

WEATHER ELEMENTS, by BLAIR, published Prentice Hall. Has an excellent chapter on often misidentified weather phenomena.

PLANETS, STARS, AND SPACE, by CHAMBERLAIN, JOSEPH M. & NICHOLSON, THOMAS D. An illustrated, non-technical explanation of the earth, planets, stars, and the universe. Prepared in cooperation with the American Museum of Natural History.

JUNIOR SCIENCE BOOK OF STARS, by CROSBY, PHOEBE. An easy-to-read, exciting story of what scientists know about the stars, planets, the moon, and the Milky Way.

CHALLENGE OF THE UNIVERSE, by HYNEK, J. ALLEN & ANDERSON, NORMAN. Discusses the nature of the universe; astronomy, and cosmology, published by Scholastic Press.

THE STORY OF THE STARS, by MALONEY, TERRY. An introduction to the universe; our solar system, our galaxy, and other galaxies. Many interesting illustrated analogies help build concepts of size and distance. Includes references to the Van Allen radiation belts and zodiacal light observation of 1960.

THE WORLD OF FLYING SAUCERS, by MENZEL, DONALD H. & BOYD, LYLE G. A scientific examination of the classic UFO reports.

THE MOON, METEORITES, AND COMETS, Dtd 1963, by MIDDLEHURST & KUIPER. Contains analysis of Soviet moon photos, a chapter on a Siberian meteorite and photos of comets and computation of various comet orbits.

THE NATURE OF LIGHT AND COLOUR IN THE OPEN AIR, by MINNAERT, Dover Publications. This is an excellent paperback written in understandable lay language.

METEORS, by OLIVIER. Standard text by foremost authority on meteors.

PHOTOGRAPHIC HISTORY OF MARS, 1905-1961, by SLIPHER, E. C., published by Lowell Observatory.

ANATOMY OF A PHENOMENON, by VALLE, JACQUES.

FIRST MAN TO THE MOON, by VON BRAUN, WERNHER.

TOTAL UFO (OBJECT) SIGHTINGS

(Compiled 15 Feb 67)

YEAR	TOTAL SIGHTINGS	UNIDENTIFIED	SOURCE
1947	122	12	Case Files
1948	156	7	Case Files
1949	186	22	Blue Book, Page 108
1950	210	27	Case Files
1951	169	22	Case Files
1952	1,501	303	Blue Book, Page 108
1953	509	42	Case Files
1954	487	46	Case Files
1955	545	24	Case Files
1956	670	14	Case Files
1957	1,006	14	Case Files
1958	627	10	Case Files
1959	390	12	Case Files
1960	557	14	Case Files
1961	591	13	Case Files
1962	474	15	Case Files
1963	399	14	Case Files
1964	562	19	Case Files
1965	887	16	Case Files
1966	1,060	30	Case Files
TOTAL	11,108	676	

STATISTICAL DATA FOR YEARS 1953-1965

(Compiled 15 Feb 67)

TOTAL CASES BY CATEGORY

	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	TOTAL
Astronomical	175	137	135	222	341	231	144	235	203	136	85	123	250	2,417
Aircraft	73	80	124	148	218	106	63	66	77	68	73	71	222	1,389
Balloon	78	63	102	93	114	58	31	22	37	19	28	20	36	701
Insufficient Data	79	103	95	132	191	111	65	105	115	94	59	99	85	1,333
Other	62	58	65	61	120	93	75	94	77	65	58	88	126	1,042
Satellite	0	0	0	0	8	18	0	21	69	77	82	142	152	569
Unidentified	42	46	24	14	14	10	12	14	13	15	14	19	16	253
TOTAL	509	487	545	670	1,006	627	390	557	591	474	399	562	887	7,704

ASTRONOMICAL SIGHTINGS

	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	TOTAL
Meteors	70	92	79	88	179	168	100	187	119	95	57	61	101	1,396
Stars and Planets	101	44	52	131	144	56	40	45	78	36	23	55	140	945
Other	4	1	4	3	18	7	4	3	6	5	5	7	9	76
TOTAL	175	137	135	222	341	231	144	235	203	136	85	123	250	2,417

OTHER CASES

	1953	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	TOTAL
Hoaxes, Hallucinations, Unreliable Reports and Psychological Causes	15	6	18	16	37	29	14	13	17	11	16	34	34	260
Missiles and Rockets	2	1	1	3	2	6	14	12	13	9	13	7	10	93
Reflections	4	6	4	3	2	7	11	9	3	3	0	2	7	61
Flares and Fireworks	1	4	8	6	8	3	5	7	4	3	3	7	4	63
Mirages and Inversions	3	2	4	1	5	2	4	5	6	3	0	2	5	42
Search and Groundlights	9	6	14	9	12	8	5	6	1	3	2	6	9	90
Clouds and Contrails	6	3	2	1	9	5	3	4	5	4	5	0	3	50
Chaff	0	2	0	1	2	6	1	4	3	5	2	1	1	28
Birds	4	7	2	6	1	1	0	3	2	2	2	4	11	45
Radar Analysis	15	7	1	8	27	3	8	6	9	0	1	2	3	90
Photo Analysis	1	1	2	4	1	7	4	6	3	2	3	6	6	46
Physical Specimens	1	6	5	3	5	10	3	7	4	15	3	8	12	82
Satellite Decay	0	0	0	0	0	1	0	9	3	3	4	3	8	31
Other	1	7	4	0	9	5	3	3	4	2	4	6	13	61
TOTAL	62	58	65	61	120	93	75	94	77	65	58	88	126	1,042

(Compiled 15 Feb 67)

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
ASTRONOMICAL	14	8	44	47	15	12	20	20	12	38	21	4	255
AIRCRAFT	8	4	32	42	31	26	29	28	14	24	22	10	270
BALLOON	0	0	2	5	3	2	7	4	2	5	1	1	32
INSUFF DATA	8	3	34	27	30	22	19	19	19	34	21	6	242
OTHER	5	1	19	15	7	5	10	5	7	9	3	3	94
SATELLITE	2	0	22	5	12	21	5	23	5	11	2	1	109
UNIDENTIFIED	1	2	5	2	1	4	3	3	4	3	1	1	30
PENDING	0	0	0	0	0	0	0	2	4	2	6	14	28
TOTAL	38	18	158	143	99	92	93	104	67	126	82	40	1,060

ASTRONOMICAL

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Meteors	8	1	3	19	5	3	10	7	4	8	8	2	83
Stars/Planets	4	6	32	23	7	8	9	10	7	29	12	2	149
Other	2a	1a	4a	5a	3a	1a	1a	3ab	1a	1a	1c		23
TOTAL	14	8	44	47	15	12	20	20	12	38	21	4	255

(a) moon (b) unusual sunset (c) unusual meteorological condition

OTHER

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL
Hoaxes, Conf. Psy	2	1	6	3	2	2	2	1	3	4	3		29
Missiles/Rockets									1		1		2
Search/Gd Lights			1	1	3		2	1		1		1	10
Flares/Fireworks				1				1			1	1	4
Reflections				3	1	2	1				2		9
Clouds/Contrails	2		3					1p	2p			1p	9
Birds			1	4	1					2	1		9
Radar Analysis									1n				1
Physical Speciman				1f			2st	1f					4
Satellite Decay	1		1										2
Photo Analysis			5bcdei	2ge			2c			1q			10
Miscellaneous			2ah			1j	1k			1r			5
TOTAL	5	1	19	15	7	5	10	5	7	9	8	3	94

(a) swamp gas (b) stellar image (c) no image (d) insuff data (e) processing defect (f) chaff (g) electric light (h) blown transformer (i) lighthouse (j) blimp (k) plasma (n) anomalous propagation (p) artificial cloud release (q) time exposure of moon reported to be UFO (r) electric wires sparking (s) indentations in ground, and soil samples (t) unknown animal

FIREBALL REPORT

Persons observing a fireball or meteor should report the information to the American Meteor Society. The information desired is contained below.

A very brilliant meteor or fireball is reported to have passed in your vicinity on . . . . at the hour of . . . . . . Will you please answer as fully as possible the following questions, which are asked on behalf of the American Meteor Society in order that permanent records of such phenomena may be obtained. When these reports are published each contributor whose report is fairly complete will be mentioned, if possible, and due credit given. It is only by the help of those who can give personal information that data can be secured for the computation of the orbits of meteors. These data are of great scientific value and all reasonable efforts should be made to obtain them. You will be unable probably to answer all questions below, but answer those you can, as they may be of the greatest importance.

(1) Give your name and address.

(2) Where were you when you saw the meteor? (If the town is small please give county as well.)

(3) Give the date, hour and minute when the meteor appeared; also kind of time used.

(4) In what direction did it appear (or in what direction was it first seen)? This is not asking in what direction it was going!

(5) In what direction did it disappear (or in what direction was it last seen)? For questions 4 and 5, simply N, E, S, or W is not accurate enough, unless these were the exact directions. If compass is used, state it; also if magnetic correction has been applied to compass reading.

(6) At what height did it appear? (Use degrees in answering.)

(7) At what height did it disappear? (Use degrees in answering.)

(8) Did it pass directly overhead (i.e., through the zenith)?

(9) If not, to which side of the zenith did it go, and how far from it? (Use degrees in answering.)

(10) Did it appear to reach the horizon? What sort of a horizon have you?

(11) What angle did the path of the meteor make with the horizon and in which direction was it then going?

(12) If you are familiar with constellations describe the path of the meteor through the sky with reference to stars.

(13) Did the meteor appear to explode?

(14) What was the duration of its flight in seconds?

(15) Describe the train if one was left. If it lasted long enough to show drift, most carefully tell in what direction train drifted. Give sketch, if possible, showing this with regard to horizon.

(16) What was the duration of the train in seconds?

(17) Did you hear any sound? How long after seeing the meteor was it before you heard this sound?

Did you hear an actual explosion? How long after seeing the explosion was it before you heard it?

(18) Of what color was the meteor?

(19) What was the size of the meteor? (Compare it with the Moon or with a planet or star.)

(20) Was more than one body seen before the explosion (if any)?

(21) What was condition of sky at time?

(22) Give names and addresses of others who saw the meteor.

(23) Please mail this reply to

CHARLES P. OLIVIER
AMERICAN METEOR SOCIETY
521 N. Wynnewood Ave
Narberth, Pennsylvania 19072

21564—8

ARRIVING FROM MARS BY UFO?

In recent years there have been many reports of unidentified flying objects (UFO's), especially since the first Soviet Sputnik went up on October 4, 1957. From time to time the question has been raised as to whether the UFO's might have come from Mars or Venus, perhaps bearing intelligent beings. Usually the answer to this question has been simply a guess which depended to a considerable extent on what the individual wanted to believe. Most scientists have been inclined to doubt that the UFO's came from Mars or Venus, preferring to credit the sightings to natural phenomena which are not as well known as they should be.

There is a logical approach to this question as to whether or not UFO's have come from Mars or Venus. It is well known that if someone on the earth wants to send a space vehicle to Mars or Venus, there are specific favorable times, times when a body can be launched so that it will travel along a minimum-energy orbit, arriving at the path of Mars (or Venus) just as that planet comes to the same point. For example, favorable times for launching a rocket to travel to Venus have been listed as October 27, 1965, June 5, 1967 and January 11, 1969, and for Mars, December 23, 1964, January 26, 1967 and February 28, 1969. (SPACE HANDBOOK, Gov't Printing Office 1959)

Of course, there are similar favorable times for launching a space vehicle from Mars (or Venus) to the earth, and for each of these launching times, there would be a corresponding arrival time at the earth. These favorable arrival times come at intervals of about 584 days for Venus and about 780 days for Mars. Actually, in each case, the interval is a close approximation to the synodic period of the planet; for Venus, the synodic period varies from 579.8 to 587.8 days, and for Mars, from 767 to 803 days.

One could then choose intervals of 20 days, say 10 days on either side of a favorable arrival date, and look to see how many UFO's were sighted in each such "favorable arrival interval," here named fai, (Plural fais). If there were no increase in the number of UFO's in these fais, then it would be unlikely that any considerable number of UFO's had been arriving from Mars or Venus.

Someone is certain to raise the question as to whether or not a Martian or a Venutian would elect to travel in a minimum-energy orbit. Here I shall assume that intelligent beings from any part of the universe will choose to travel by means and paths that will minimize the expenditure of energy.

This fai approach to the problem can be carried a step farther. One can make a list of the UFO's observed in the fais, and look at the record of each to see if the UFO was observed traveling in the direction it would have if it came from Mars (or Venus) in a minimum-energy orbit. Roughly speaking, a space vehicle from Mars should overtake the earth from behind and one from Venus should be overtaken by the earth. Thus one could determine whether the path of approach was associated with the proper radiant point in space; here we use the term in the sense in which it used in connection with meteors.

Now to look at the evidence! A list of UFO's sighted between September 8, 1956 and December 31, 1963 was examined. Nine fais of 20 days were found in this interval, 5 for Venus and 4 for Mars. Circular paths were assumed for Venus, Earth and Mars in computing travel times for space vehicles, but no particular difficulty is encountered if one elects to allow for the eccentricities of the various paths. In Table I below, the number of UFO's reported in each fai of 20 days is given, and is to be compared with the average number of UFO's per 20-day interval outside the fais, namely, 1.88.

TABLE I

FAI	PLANET	NUMBER UFO's
1956 Sept. 8-28	Venus	1
1956 Dec. 5-25	Mars	1
1958 Apr. 16 - May 6	Venus	1
1959 Feb. 10 - Mar. 2	Mars	2
1959 Nov. 18 - Dec. 8	Venus	0
1961 Mar. 26 - Apr. 15	Mars	1
1961 June 28 - July 18	Venus	1
1963 Jan. 29 - Feb. 18	Venus	2
1963 May 1 - 21	Mars	1
1956 Sept. 28 to 1963 Dec. 31 outside fais		242 in 2,570 days

Thus the evidence seems to indicate that Martians and Venutians have not been arriving in large numbers if at all. When one goes back to examine the direction from which the UFO's arrived, we find not a single case of the UFO coming in from the proper direction to indicate that it had originated on Mars or Venus.

Charles H. Smiley, Brown University

21564—8½

Extract from Wernher von Braun's book First Men to the Moon,
Copyright 1958, 1959, 1960 by Dr. Wernher von Braun, published
by Holt, Rinehart and Winston of Canada, Ltd.

"Question: What is your opinion on 'U.F.O.'s'?"

"Answer: There is a rational and rather straight-forward explanation for the great majority of 'sightings of unidentified flying objects,' or 'flying saucers,' as they are more familiarly called. During the last ten years, official U.S. investigators have tabulated about six thousand 'sightings.' They could account for all but two per cent as belonging to any of the following categories:

High-flying balloons of various kinds
High-flying aircraft illuminated by the sun after the sun had set on the ground
Nightly 'Fata Morgana' type reflections in the atmosphere of distant light sources on the ground
Artificial satellites of U.S. or Soviet origin
Meteorites and fireballs
Birds
The Planets Venus or Jupiter
Searchlights illuminating cloud layers
Hoaxes perpetrated by pranksters

Even the most ardent believers in flying objects of extra-terrestrial origin will usually concede that most reported 'sightings' can be traced back to one of these sources. But it is that unaccounted two per cent that makes enthusiasts cling tenaciously to their conviction.

I cannot account for the mysterious two per cent, either. But a lifetime spent with testing of guided missiles has taught me to be extremely careful with eye-witness accounts on rocket firings running into some in-flight trouble. Of three experienced observers questioned after a typical mishap, one swore that he clearly saw a part coming off before the rocket faltered; a second hotly denied this but claimed that the missile oscillated violently before it veered off the course; while the third trained observer saw neither a part coming off, nor an oscillation, nor any veering off the course but insisted that the rocket was flying perfectly steadily until it was abruptly ripped apart by an internal explosion.

Such contradictions in the eyewitness accounts of old rocket men are by no means an exception; we are almost invariably confronted with this situation. Yet we are dealing here with experienced observers who not only had seen many firings, but who had the great advantage of being mentally prepared for the imminent test.

For this reason I am highly skeptical about the objective of any 'sighting' report of a fleeting, mysterious object in the sky submitted by an equally surprised and unexperienced observer. And those unaccounted two per cent of U.F.O.'s absolutely fail to raise my blood pressure. To me, ninety-eight per cent is a mighty good batting average. I wish we could account for ninety-eight per cent of what we observe in many other fields of human endeavor! Yet, ever since the Middle Ages it has not been customary for science to call on ghosts or witches - or little green men from Mars - whenever we are confronted with a phenomenon for which we do not yet have a satisfactory answer.

To those who, either through personal observation or through hearsay based on other people's accounts, still insist that objects of extra-terrestrial origin are roaming through our atmosphere, I can only say that I have never seen such an object and cannot believe in their existence until I do."

NIGHTTIME ASTRONOMICAL SKY SURVEYS AND UNIDENTIFIED FLYING OBJECTS

Carl Sagan

Harvard College Observatory
and
Smithsonian Astrophysical Observatory
Cambridge, Massachusetts

There are several instances of extended observations of large fields of view of the night sky by trained astronomical observers. These observations are usually performed in the context of meteor studies. One such is the Harvard Meteor Project, in which visual and photographic observations were performed (the latter with Super-Schmidt cameras, and a 60 degree field of view) in New Mexico during the period 1954-1958. Note that this is a locale and period characterized by extensive reports of unidentified flying objects. In all, a surface area of 7×10^3 km^2 was observed to 80 km altitude for a total period of 2×10^5 minutes. Observations were good down to magnitude +4. No unexplained objects were detected.

A second example of such an observation program is the photographic and visual Prairie Network of the Smithsonian Astrophysical Observatory. The total area covered is about 10^6 km^2, but only bright objects - brighter than magnitude -8 - can be photographed. The cameras cover essentially the entire sky, and the network encompasses parts of the states of Iowa, Kansas, Nebraska, South Dakota, Oklahoma, Illinois, Colorado and Missouri. In 2,500 hours observing to date, no unexplained flying objects have been detected. In fact, in the cases of both the Harvard Meteor Project and the Smithsonian Astrophysical Observatory Prairie Network, no bright moving objects other than meteors and occasional aircraft were detected. An even more extensive meteor survey, worldwide in scope, was performed during the I.G.Y. under the direction of Dr. Peter Millman of the National Research Council of Canada. Unfortunately, much of this data is still unreduced.

These sky surveys are much more extensive in area and time than such previous stellar astronomical surveys as the Palomar Sky Atlas, which also showed no unusual objects. Especially considering the experience of the observers in the foregoing observations, it seems likely that the frequent reports of unidentified flying objects observed at night by individuals relatively unfamiliar with the skies are due to misinterpretations of common astronomical objects.

ANNEX "B"

QUESTIONS AND ANSWERS ABOUT THE "CONDON REPORT"

The Scientific Study of Unidentified Flying Objects was conducted by the University of Colorado, under contract to the United States Air Force, under the direction of Dr. Edward U. Condon. The Final Report, commonly referred to as the "Condon Report" was published by Bantam Books, New York, in January, 1969, under the title "Scientific Study of Unidentified Flying Objects" and contains the complete text of the original edition. Not one word has been omitted, according to the publisher.

2. As a result of the general impression conveyed by press reports that the investigation proved that there is nothing significant to UFO sightings, listed below are a few of the questions which must be asked concerning the "Condon Report", with the answers provided by the Report.

Notes:

1. Every effort has been made not to take quotations out of the general context of the Report.
2. Page references refer to the Bantam Edition of the Report.

Question 1. Does the Report claim to give the "final answer to what all UFOs are?

A. NO.

Question 2. Does the Report add anything to scientific knowledge?

A. NO.

Question 3. Did the Committee encourage or solicit submission of sighting reports by the public?

A. NO (p. 11).

Question 4. Approximately what percentage of all sightings were reported to the Committee?

A. Approximately 10% at most. (p. 11).

__Question 5.__ Did the Committee investigate all reports that were received?

A. NO. "Our available resources for field study enabled us to deal only with a small fraction of the reports coming in", (p. 11). (i.e. a small fraction of the 10% reported).

__Question 6.__ Was the Committee able to explain satisfactorily all or nearly all cases which were investigated?

A. "A common situation was one in which the lack of evidence made the investigation totally inconclusive" (p. 61).

__Question 7.__ Were there any cases investigated which could be explained __only__ in terms of "strange vehicles"?

A. "the label 'unidentified' does not necessarily imply that an unusual or strange object was present. On the other hand, some cases involve testimony, which, if taken at face value describes experiences which can be explained only in terms of the presence of strange vehicles...... These cases are puzzling and conclusions regarding them depend entirely upon the weight one gives to the personal testimony as presented". (p. 62).

__Question 8.__ Did the investigation determine that most UFO witnesses are emotionally disturbed or irresponsible people?

A. "In our experience, the persons making reports seem in nearly all cases to be normal, responsible individuals. In most cases they are quite calm, at least by the time they make a report. They are simply puzzled about what they saw and hope that they can be helped to a better understanding of it. Only a very few are obviously quite emotionally disturbed, their minds being filled

with pseudo-scientific, pseudo-religious or other fantasies. Cases of this kind range from slight disturbance to those who are manifestly in need of psychiatric care. The latter form an extremely small minority of all the persons encountered in this study. While the existence of a few mentally unbalanced persons among UFO observers is part of the total situation, it is completely incorrect and unfair to imply that all who report UFOs are "crazy kooks", just as it is equally incorrect to ignore the fact that there are mentally disturbed persons among them". (p. 10).

Question 9. Is it expected that the conclusions of the "Condon Report" will meet with general agreement among scientists?

A. "If they (other scientists) disagree (with the conclusions) it will be because our report has helped them reach a clear picture of wherein existing studies are faulty or incomplete and thereby will have stimulated ideas for more accurate studies. If they do get such ideas and can formulate them clearly, we have no doubt that support will be forthcoming to carry on with such clearly-defined, specific studies. We think that such ideas for work should be supported." (p. 2). (Insertions in parentheses made by author of this brief).

Question 10. Did the Committee find that Project Blue Book had done an adequate job of investigating UFOs?

A. "Material on a number of older cases was obtained from the Aerial Phenomena Office (Project Blue Book) at Wright-Patterson Air Force Base, Ohio. In many cases, these files were not sufficiently organized or complete to permit an intelligent evaluation of the report." (p. 76).

APPENDIX 213

BRIEF TO THE SENATE SPECIAL COMMITTEE

on

SCIENCE POLICY

by

Michail F. Smith

Part A: Major conclusions and recommendations.

I. Conclusions.

a. Canadian science is faced with a doubleheaded quantitive crisis, as this country suffers from a lack of both qualified personnel and scientific facilities.

b. Canadian universities are not producing sufficient numbers of science and engineering graduates.

c. A lack of funds is proving detremental to the progress of Canadian science.

d. The Canadian taxpayer does not support scientific projects because he has little or no knowledge of their benefits to him and his way of life.

e. Canadian science must dedicate itself to the betterment of the human condition.

2. Recommendations.

a. The federal government once it has decided to put money into a scientific project should make contingency plans in case the original project is abandoned.

b. The federal government should consider making loans to those students who intend to study science at the University.

c. The federal government should consider the possibility of establishing a foundation for the financing of worthwhile scientific projects.

d. The federal government should help to open new channels of communication between taxpayer and scientist.

e. The federal government should encorporate into it's scientific policy a statement on the uses and misuses of science.

Part B: Project Century 70 and it's importance to the Canadian Community

1. Basic Description.
2. Educational Program.
3. Research Program.

Michail F. Smith,
366 Oxford Street,
Winnipeg 9, Manitoba.

January 1, 1969

APPENDIX 214

A PRIVATE BRIEF TO THE SENATE OF CANADA

SPECIAL COMMITTEE ON SCIENCE POLICY

May, 1969

by K. O. Bardwell

a Canadian citizen employed by

Department of Energy, Mines and Resources

(Physical Metallurgy Division, Mines Branch)

1. PURPOSE OF SUBMISSION:

This brief is concerned with, first, the efficient use of the human resources of the research departments of the Canadian government; secondly, with the careers and morale of the professional and technical people who make up that work force and, thirdly, with the integrity of the personnel policies which, as applied, have had serious effects on the retention and development of career scientists and technologists.

2. It will deal with and make recommendations on:
   A. Support ratios
   B. Mobility of trained workers
   C. The TIRL program, which cheats everyone in the area
   D. Specialised post-employment training
   E. Personnel evaluation reports
   F. The Classification Revision program
   G. Career development
   H. A suggestion to employ people who are not part of any technical group for routine duties in research labs
   I. A request for further information from all agencies

3. SUPPORT RATIOS:

Canada's scientific support pyramid in some areas is inverted a la Expo. When you have too many Ph.D's for the available technicians and technologists you have professionals leaving for universities where, as you were told by a spokesman for the Department of Agriculture, a man may have the support of a number of graduate students. It is a pathetic waste of trained scientists, technologists and technicians to have support ratios so low that each person must perform jobs below his potential. Nobody then grows at his own rate, work which might have been done becomes impossible and all become disenchanted. Good people have left because someone evidently decided on niggardly support ratios which bear no relation to work potential with modern equipment and technology.

4. Recommendation: that a survey, with power to recommend support staff increases, be made in all divisions of research departments. Where this survey finds scientific and technical staff performing non-specialised duties because of lack of personnel to perform these lower rated duties it should recommend employment in these areas of extra ancilliary staff.

5. MOBILITY OF TRAINED WORKERS:

Mobility of trained workers within the various departments and agencies of the government should be unhampered by forfeiture of benefits. Leave credits are not trasnferred between agencies and departments so that a man coming from, say, AECL, to the Mines Branch, must start anew to accumulate the service which entitles him to a week of extra annual leave. Positions are not advertised in the

obvious areas of related interest. Why must an employee lose all his back pay if he moves between contract dates? Why are there discrepancies between evaluations of similar jobs with an agency as compared to one with a department?

6. Recommendations: That impediments to mobility between agencies and departments be eliminated; that long service leave and other benefits be credited between agencies and departments; that <u>all</u> vacancies be advertised in all areas where personnel who may be qualified to fill them work. Departments should be reminded of the special skills which may be acquired in other areas of government employment.

7. THE TIRL PROGRAM, which cheats everyone in the area:
During the last two years the government has introduced unilaterally a scheme for the recruitment of graduates of Technological Institutes for the technical and scientific departments. I am surprised that these departments have not told you about their TIRL's, the acronym by which these young people are known. Their situation is that of a graduate apprentice. An outsider might expect them to be undergoing training, perhaps on job rotation. In reality few are getting any planned training. Instead, they have been slotted into positions willy-nilly and paid at a rate which approximates that of the starting average for graduates, plus increments and adjustments to keep them equal to the succeeding year's class. They have been put into positions which were not put up for competition when they fell vacant. They have thus been the instrument to keep ambitious present employees from deserved promotions and to lower high level positions to learner slots. For instance, a fairly complicated high order position which might otherwise have been gone to a Ryerson grad with 10 years of increasingly responsible experience in a research department may be filled by a TIRL. The position level initially remains at Engineering and Scientific Support Level 6, the boy is paid at the novice TIRL rate for two years and may then be paid at the bottom of Level 3. Of course, he cannot work at Level 6 so we may expect the position to be revalued, downward. In the interval the man who was obviously suited to move in at the proper level 6 (a slight promotion or a change of duties) stays where he was -- or leaves for a more discerning and rational employer. The people who should be moved as a result of one proper slotting lose their incentives and several good people suffer.

8. Whatever the original intent of the TIRL scheme, launched without consultation with the unions or staff associations, the effects are clear. They have frustrated the hopes of hundreds of capable, trained present employees. They have stamped on the merit principle by denying the right to compete for jobs for which they were qualified. They have cruelly raised the hopes of TIRLs by letting them believe they would move into jobs at the full evaluation level, over the heads of present employees. Forgetting, if you can, the human and career frustration points, it has cost research efficiency and thus, money. Nobody can assess the

final cost yet because during the entire TIRL period every technician and technologist has been waiting for the BCRs reclassification of positions. Many have had thousands of dollars tied up in back pay. Now, when it is clear just what each individual's ultimate pay and growth potential is to be you may expect resignations to start. There will be few transfers, because positions are being filled with more TIRLs. As valued support personnel leave you will notice Ph.Ds leaving too. As the TIRLs acquire basic experience on complex jobs they will leave for positions at outside market value. Another year of the same treatment will not help the basic problem.

9. Recommendations: The Commission should instruct the research departments to resume normal competitions to fill all vacant positions, except legitimate training and rotational situations. They should also order all positions to be filled at not more than two full levels below the rated level of the position. They should order the end of TIRL placements in the electronics and any other series where the basic intake qualifications are the same, except for positions involved in a formal training program. TIRLs filling positions for which they have insufficient experience should be moved to appropriate positions, or put on rotational or special training programs, or retained at the level suggested above (a Level 6 position should not be filled below the bottom of Level 5.) No position should be reduced in level because of the placement of a TIRL in that position. Personnel officers should be ordered to stop telling TIRLs that they will be part of a Technologist Class. (There is no record of any intention of introducing such a group now. Such suggestions to new recruits are divisive.)

10. SPECIALISED POST EMPLOYMENT TRAINING:

In an advancing technology special courses and seminars are eseential to keep technical support personnel up-to-date. Some departments run frequent training programs for technical employees. Others expect men to do the impossible. Equipment manufacturers and others offer courses, service seminars and conferences. If travel to and from the course, plus expenses in the city where it is held, must come from the general conference and travel allocation of the branch in competition with conference expenses for researchers there is less likelihood of the branch taking advantage of the specialised training available. Proper training permits full utilisation of expensive equipment.

11. Recommendation:

There should be funds available for training courses, allocated separately from those intended to cover travel to scientific conferences, etc. These should be adequate to cover the expense of sending personnel on available courses covering present equipment. When major equipment purchases are made committments to train maintenance, and in some cases operational, personnel should be obtained from the manufacturer.

12. PERSONNEL EVALUATION REPORTS:

Annual assessments of each employee's attitudes, accomplishments and potential are common personnel evaluation techniques. Few employers, however, use these methods in the way they are used in some federal departments. Here the efficiency report is written up and filed. In most cases it is not discussed with the subject at all so that he is not made aware of his failings, reassured of his progress, nor is he even aware of being judged. To be of use the report should be discussed with the subject, who should indicate his awareness of its contents by signing it, perhaps with appropriate comments. That is what has to be.

13. Recommendation:

Efficiency reports must be discussed with the subject employee, who should indicate his knowledge of its contents by signing it. No report which has not been signed should be in any employee's file, nor should any such report be used against the subject at any time.

14. THE CLASSIFICATION REVISION PROGRAM:

I fully support the aims of the Bureau of Classification Revision. As a member, and finally the chairman of the 1960 Technical Committee of the Ottawa CSAC, later of the PSAC, I asked for comparability of positions in the Public Service with those of similar complexity and responsibility level in the outside world. Initially, we were trying to get the 1949 Technician series altered to embody realistic intake educational and training requirements. We were delighted when BCR came along and we've been pleased with the upward revisions in the level of some jobs. However, when we talk about the specialist who has been delayed in evaluation, or has been wrongly evaluated because he didn't fit the pattern of certain recognisable large groups I am not at all happy. One professional has filled in three BCR questionnaires for three different classification groups... many have done two, management has requested reviews of hundreds of positions in several series. Back pay in cases where serious evaluation disputes arise can run into many thousands of dollars. Reviews are taking four months or more after positions have been rewritten.

15. Recommendation:

More resources should be devoted to reclassification of technical and professional staff.

16. CAREER DEVELOPMENT:

In order to permit reward for good work many employers have flexible incentive raises. In general in the Public Service the rule is one increment at a time, no matter how good. It should be possible to compensate for extra effort and good work by awarding extra increments, as is done in the Research Scientist Group.

17. Recommendation:

Technicians and technologists should be able to win extra increments in salary for good work.

18. A SUGGESTION TO EMPLOY PEOPLE WHO ARE NOT PART OF ANY TECHNICAL GROUP FOR ROUTINE DUTIES IN RESEARCH LABS:

After the war the government hired some people to train for technicians after completion of elementary school. Later the intake requirement was changed to completion of secondary school. Now it is effectively the completion of a three year technological institute course. We still have some routine jobs which require little technical training. Some are dead-end jobs, needing little skill. Others are bits of manual and clerical functions which must be done but which aren't worth the money you pay for a career person. In revising the series the Commission forgot these functions and they haven't provided any mechanism to hire non-career personnel for dead-end work. A serious human rights aspect which involves the exclusion of people with lower educational and training accomplishments from whole areas where they really are needed should be considered. These people should be used to fill the gap in the system created by upgrading the intake requirement. We should not waste people who are able to do career work, nor should these people be untouchable because they do not fit an irrelevant standard.

19. Recommendation:

A new class of laboratory helper with low growth potential should be set up to cover routine dead-end work in labs. This group should have low educational requirements, relating to the actual work to be done. There should be a preference clause for groups for whom little work is now available. The handicapped, older people and some housewives would appreciate these jobs.

20. REQUEST FOR FURTHER INFORMATION FROM ALL AGENCIES:

Following the rather narrow guidelines of your committee the various departments and agencies have reported on the numbers, languages skills and origins of their professional staffs. You did not ask them to report on the time expended on language training, the gaps between courses or the interruptions of work by broken immersion courses. Thus you did not get any recommendations on the best way to run a language training system for scientists.

21. Recommendation:

Departments and agencies should be asked to supply statistics on language course participants numbers, the patterns of their absences and the apparent effect on their projects. Nobody who is presently engaged as an administrator or manager should be on cyclic courses.

22. Summation:

I have tried to deal with problems which are general to many research areas of government. As a spokesman for technicians in the CSAC, the PSAC and now the IBEW I have heard many complaints from technical people about the functioning of our scientific Civil Service. We are generally concerned about efficiency, morale and human rights. I hope you will consider these points as pertinent to increasing our net scientific yield.

BACKGROUND OF KENNETH OLIVER BARDWELL

Born March 8, 1924 at Benalto, Alberta.

Joined Canadian Army at 17. Spent most of his war in school; became Radio Mechanic (Radar) and Wireless Telecom. Mech.

Spent the next ten years in the technical side of broadcasting (radio and T.V.)

Went to Atomic Energy of Canada at Chalk River in 1956, worked in reactor buildings on electronic instrumentation.

In 1959 came to the Mines Branch in Ottawa to work on electronics; is now instrumentation technologist for the Physical Metallurgy Division.

He has been active in union work and involved in policy committees. He is an Honourary Life Member of the National Component of the PSAC and is a candidate for the Vice Presidency of his national local of the IBEW.

He believes in involvement, made three submissions to the Royal Commission on Health Services (the Hall Commission) and one to the Anderson Commission which made recommendations on the organisation of some groups in the Public Service. He attended the 1968 CLC Seminar on Human Rights in Ottawa to emphasise to organised labour the problems being created by unrealistic educational and training requirements for simple jobs. He is concerned that a new type of discrimination against the older and handicapped groups of workers is being set up.

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BRIEF TO THE SENATE OF CANADA

SPECIAL COMMITTEE ON SCIENCE POLICY

ON A NEW POLICY FOR FOOD RESEARCH IN CANADA

June 1969.

Submitted by, -
W.R. Smithies,
43 Woodlawn Ave. West,
Toronto 7, Ontario

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CURRICULUM VITAE

SMITHIES, Walter Rahe, B.Sc., Ph.D., M.C.I.C., F.R.I.C.

Born in Liverpool, England in 1922.

B.Sc., (Chemistry) in 1942 and Ph.D. in 1949.
both from the University of Liverpool.

1942 to 1946, Chemist at British Insulated Cables Ltd. England.

1949 to 1953, Biochemist at Rothamsted Experimental Station, Harpenden, England.

1953 to 1955 N.R.C. Post Doctorate Fellow in the Division of Applied Biology, Ottawa.

1953 to 1961 Scientific officer at the Defence Research Medical Laboratories, Downsview, Ontario, working on the development of freeze-drying.

1961 to 1967 Vice-President of Canada Freeze-Dry Foods Ltd., Oakville, Ontario.

1967 to 1969 Vice-President of Freeze-Dry Foods Ltd., Oakville, Ontario Resigned in January.

At present temporarily occupied as a consultant while seeking permanent employment.

SUMMARY

The traditional research role of the Federal Department of Agriculture - to work primarily on behalf of the farmer - is outdated. Developments in food technology make it essential to think in terms of the food supply chain as a whole, farmer - processor - distributor - consumer and research should be applied to benefit all members.

More effort is needed in the study of new processes and new foods to assist in the forecasting of developments that could necessitate changes in the pattern of Canadian agriculture.

RECOMMENDATIONS

1. The Department of Agriculture should retain primary responsibility for, and devote more effort to food research.

2. It is essential that this research be planned to benefit, to the greatest extent, all members of the food supply chain, farmer - processor - distributor - consumer.

3. Greater efforts should be made to study new processes and new foods and thereby assist in the forecasting of developments that could necessitate changes in the traditional patterns of Canadian Agriculture.

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1. The Aims of Government Food Research

There is a great need for government research on food in Canada, both in-house and extra-mural, for relatively little is conducted by the food business. Research and development by the industry is often confined to adapting U.S. products to Canadian taste or revising the ingredients of a U.S. recipe to bring them in line with our own food and drug regulations.

To fill the gap, government research is necessary:

a) To ensure the efficient utilization of agricultural products as food.

b) To study new developments in foods and food processing and their effect on market requirements, so that needs for change in traditional patterns of Canadian agriculture can be anticipated.

2. Agriculture and Food go Together

In days gone by we were satisfied to eat whatever was produced by the farmer. Today, agriculture must produce to the exacting requirements of a highly technical food industry.

Canada's agriculture cannot be shielded from the influence of technological developments in other countries whereby new markets for agricultural products can be created and traditional markets destroyed.

Research policies must, therefore, recognize the need for a close relationship between the farmer, the processor, and distributor. This has been stressed by Dr. R.P.A. Sims.[(1)]

In some quarters there is doubt whether extensive research in the primary industry of agriculture can be justified for it is "a declining sector, relatively, in the Canadian economy".[(2)] To the contrary, the agriculture and food industries combined form a viable and expanding group worthy of research support at every link along the food supply chain that involves farmer - processor - distributor - consumer. It is important that a government food research policy takes this point of view.

3. <u>The Research Policy of the Federal Department of Agriculture</u>.

As is appropriate, most of the food research in Canada is done by the Department of Agriculture. Unfortunately research by the Department is performed with the interests of the farmer primarily in mind. Other applications have to be played down as the following quotations make clear.

(The Department is) "To engage in scientific activities for the solution of the problems of the primary industry, i.e. farm problems."[(3)]

(First, the Department) " is responsible for conducting sufficient research to maintain effective regulatory, stabilization, assistance and rehabilitation functions; and second, it is responsible for ensuring that Canada has a research program adequate to maintain its agriculture as a healthy and progressive industry."[(4)]

"The primary purpose of the Research Branch is to apply the principles and methods of scientific investigation to the everyday problems of agriculture, to the end that farmers may become more efficient and prosperous, and may produce and market better quality food products for the nourishment of the people. In pursuit of this objective, efforts are made to raise by amendment and management, the productivity of the soil; to improve the yield and quality of crops as well as cropping practices; to better the quality and productivity of livestock; and to protect crops and livestock from the ravages of insets and other pests."[(5)]

"The primary goal of research in the CDA is to improve the efficiency of farm production: More produce of better quality at less cost per unit."[(6)]

The possibility that Department of Agriculture research might be of benefit to or conflict with secondary industry is dealt with as follows:

"Industry:- Our first responsibility, as indicated in our statement on science policy, is tothe primary industry - the farmer.

Nevertheless, because of the interdependence between primary and secondary industry, much of our research and development is concerned with problems of manufacturing and distributing farm supplies and farm products. Although the first beneficiary of such scientific work is often secondary industry, the work is not undertaken unless there are prospects that farmers will benefit too." (7)

4. Department of Agriculture Research on Food.

So much stress on helping the farmer greatly restricts the kind and quantity of research that can be done particularly in relation to food. In many ways food research is more easily applied at the consumer - processor end of the food supply line than the farmer's end.

According to the 1967 Department of Agriculture Research Report less than forty professionals were involved in food research out of a staff of about one thousand. It is not surprising that the article by Dr. Robert Glen describing present and potential activities in the Research Branch does not even mention the word "food". (8)

The 1967 Research Report however, lists the following food research projects:- potato quality and processing particularly with reference to french fries, plant lipoproteins, candied fruits, carbohydrates of honey, cheese quality and microbiology, beef tenderness and beef proteins, plant waste disposal, fruit and vegetable storage, irradiation of peaches, freezing techniques, microwave heating, drum drying, and a patented continuous cooker cooler for canning operations.

Without doubt, this line of research would help the utilization of farm produce, although of course, much more could be done and the range of subjects widened.

However, it does not indicate an interest in studying and anticipating new developments that could influence and necessitate changes in the agriculture and food industries of Canada.

Neither is there mention of the role that the food research staff could play in advising the Economics Branch about potential developments in technology and their possible effect on agriculture.

5. The Role of the N.R.C. in Food Research

Although, according to Dr. Woodward "The primary responsibility for food research lies with the Department of Agriculture for food uses of agricultural products. The

primary responsibility for non-food uses, industrial uses of agricultural products, lies with the National Research Council," (8) the N.R.C. is in fact involved in food storage and Processing research. In 1963 seven projects were in hand but in 1968 had been reduced to two.

The projects were to do with:- frozen poultry, refrigerated transport design, cold storage of fruits and vegetables, milk proteins, egg quality and, (retained in 1968), beef quality and contamination of beef and poultry by micro-organisms. (9)

These studies form a useful addition to Department of Agriculture research but the same criticism applies, they are concerned with today's farm and food patterns only.

6. Research by other Agencies.

Other agencies are very much influenced by the Department of Agriculture Research Branch in their own research programs as the following quotation indicates. "Although the Research Branch is the principal agency for agricultural research in Canada, it is not the only one. Duplication of effort is avoided through the agency of an Agricultural Services Co-ordinating Committee representative of the federal and provincial departments of Agriculture, along with national and provincial research councils, and agricultural schools and colleges.

The program of individual establishments fits into the broad outline of the national program but each establishment is responsible for proposing projects that will most benefit the agriculture of its region or its particular field of scientific responsibility." (10)

7. Research or Restrictions ?

My main concern in this brief is that Department of Agriculture research is preoccupied merely with the improvement of traditional farming practice. Although reference is made in their brief to problems associated with long term changes in demand for agricultural products and rapid changes in industrial technology, (11) - no concrete proposals are brought forth to do something about the matter.

In the past, farmers have been protected from change by restrictive legislation. The Department of Agriculture is in a powerful position to do this for it administers thirty-three separate acts, although, with the increased power of the consumer today, it is doubtful if restrictions can be imposed as easily as they used to be.

The classical example is the prohibition of margarine for sixty-two years to protect the dairy farmer. It should be noted that the development of rapeseed and soybean crops came only in the 1950's when, as a result of the legalization of margarine at the end of 1948, there developed a large Canadian market for edible oils.

Even at the present time certain other dairy substitutes (filled milk products) remain prohibited in Canada although marketed in other countries. But progressive industrial technology has found ways of evading the restrictive clauses in the Dairy Products Act so that coffee whiteners and toppings can now be manufactured and sold successfully in competition with dairy creams.

To explain the change needed in research attitudes take the specific example of meat analogues made from vegetable protein and now in commercial production in the U.S.A. How should the Canada Department of Agriculture react to the threat they offer to cattle and hog farmers ?

If precedent is followed, the Department will seek to restrict the use of these substitutes. To the contrary, properly motivated by an aggressive research outlook the reaction should be to: -

A) Intensify research on cattle and hog production to meet the price competition of the substitutes.

B) Initiate research on vegetable crops and the manufacturing techniques involved so that the textured vegetable protein can be produced economically from Canadian sources for domestic sale and export.

Continued research and development in the government and industrial food laboratories of the U.S.A., Europe and Great Britain can be expected to provide one problem after another to Canadian agriculture in the coming years.

In the long term, the Canadian farmers and economy as a whole will be best served by a forward thinking research policy, strong in food research, applied to meet the challenge.

8. The Influence of other Federal Government Departments on Food Research

Although not directly involved, both National Health and Welfare and the Department of Industry Trade and Commerce influence food research and, happily, are less conservative in their attitude than the Department of Agriculture. National Health and Welfare co-operate in the consideration of new food processes for approval. Work is in hand so that standards of identity will be available if and when agriculture permits the sale of milk and meat substitutes.

The Department of Industry Trade and Commerce actively promotes research and development in the food processing industry. Several product studies have been made including one on dairy substitutes.(12)

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REFERENCES

1. Dr. R.P.A. Sims, - Food is the Unifying Concept in Agriculture, Chemistry in Canada, Vol. 20, No. 6, June 1968, page 9.

2. Ronald S. Ritchie, Has Canada acquired a Science Policy ? - An overview. Science Forum, Vol. 1, No. 3, June 1968, page 3.

3. Proceedings of the Special Committee on Science Policy, No. 10, Brief submitted by the Department of Agriculture, page 1131, line 1.

4. Proceedings of the Special Committee on Science Policy, No. 10, Brief submitted by the Department of Agriculture, page 1132, line 2.

5. Canada Agriculture - The first hundred years, Appendix III, page 67. Queens Printer, Ottawa, 1967.

6. Dr. R. Glen, Agriculture: Greater Farm Efficiency with Managed Research, Science Forum, Vol. 1, No. 3, June 1968, page 11.

7. Proceedings of the Special Committee on Science Policy, No. 10, Brief submitted by the Department of Agriculture, page 1137, line 24.

8. Proceedings of the Special Committee on Science Policy, No. 10, Evidence submitted in support of Brief by the Department of Agriculture, page 1066.

9. Proceedings of the Special Committee on Science Policy, No. 21, Supplementary Report presented by the National Research Council of Canada, pp.3280, 3281.

10. Canada Agriculture - The first hundred years, Appendix III, page 68. Queens Printer, Ottawa, 1967.

11. Proceedings of the Special Committee on Science Policy, No. 10, Brief submitted by the Department of Agriculture, page 1151.

12. Substitute Dairy Products and their effect on the Canadian Dairy Industry. A Report prepared at the request of the National Dairy Council of Canada by Food Products, Canada Department of Industry, Ottawa, August, 1968.

APPENDIX 216

B R I E F

submitted by

THE ROYAL ASTRONOMICAL SOCIETY OF CANADA 1968
252 College Street, Toronto 2-B

to the

Special Committee of the Senate on Science Policy

SUMMARY

1. The Royal Astronomical Society of Canada has for a century played a part in supporting the study of astronomy in Canada. We believe, therefore, that we are competent to present the case for astronomy in Canada's science policy.

2. There is a cultural justification for the study of astronomy which must not be ignored.

3. The pragmatic justification of support for astronomy may be too easily overlooked. It stems from the lead which astronomy so often gives to basic physical research.

4. Canada's position in international astronomy has been enviable, but is now threatened by obsolescence of equipment. Strong financial support on the part of Government is urged.

5. Both university and government astronomers have roles to play. In order that their positions and needs be better understood, we recommend that an astronomer be appointed to the Science Council.

1. THE ROYAL ASTRONOMICAL SOCIETY OF CANADA 1968

This Society, incorporated by letters patent under the provisions of the Canada Corporations Act, has this year taken over the assets and membership of The Royal Astronomical Society of Canada which has been operating under a Province of Ontario Charter since 1890 and which in turn grew out of the Toronto Astronomical Club founded in 1868. Its principal aim over the past century has been to stimulate interest and to promote and increase knowledge in astronomy and related sciences.

The Society comprises 16 Centres in the principal cities of Canada from coast to coast, plus members in other parts of Canada and throughout the world unattached to Centres. The total membership is about 2500. Most Canadian and many American and European professional astronomers are members, but the majority of members are amateur astronomers.

The Society has published for the past 62 years the Observer's Handbook (annually) and the Journal of The Royal Astronomical Society of Canada (bi-monthly). It is through this latter publication, the only Canadian journal of astronomy, that the Society has effected a significant encouragement to astronomical research in this country. In this way and also through its meetings, the Society has helped bring the Canadian contributions to astronomy to the attention of the astronomers of the world and of the Canadian public.

The Society has been able to contribute in other ways to Canadian astronomy: many distinguished Canadian astronomers first had their interest in the subject

awakened through student membership in the Society. Three important and continuing bequests to Canadian astronomical research have resulted directly from the testators' membership in the Society; these are David Alexander Dunlap, Walter John Helm and Carl Reinhardt. A life-long supporter of the Society and the Editor of its publications for fifty years, Professor C. A. Chant, also bequeathed the bulk of his estate to Canadian astronomy.

It is for these reasons that The Royal Astronomical Society of Canada considers it a duty to submit this Brief on Science Policy.

While the Society recognizes the large scope of the problem in hand by the Special Committee, we feel most competent to stress the role and the needs of astronomical research, and it is to that end that we confine our remarks.

2. ASTRONOMY AS A MEASURE OF A COUNTRY'S PROGRESS

In an address at the opening of the first American astronomical observatory at Cincinnati in 1843, John Quincy Adams said:

> The progress of a people on
> its career of civilization may
> be gauged by the number of
> observatories on its soil.

It would not be difficult, 125 years later, to demonstrate the continuing validity of this remark of Adams'. If we confine ourselves to Canada we can point with pride to the world-renowned accomplishments of Canadian astronomers and to the flourishing of

astronomical training and research in our universities and government research centres.

While there are important pragmatic justifications for the expenditures of public funds on astronomical research, we must not lose sight of the cultural justification to which John Quincy Adams referred. Its validity, indeed, is growing with the public's interest in astronomy, an interest which stems from everyone's inborn curiosity about the universe: How big is it? What lies beyond the unobservable? How did it come about? Are there other humans out there?

3. ASTRONOMY OFTEN LEADS IN RELATION TO OTHER SCIENCES

The beginning of astronomy in Canada was directly related to the problem of surveying a large undeveloped country; accordingly positional astronomy and time determination were emphasized. Canada played an important role in these branches of astronomy, and for different reasons still continues to do so. However, early in this century Canadian astronomers began to pay increasing attention to other astronomical studies which, at first sight, appear to have little relation to economic needs and to the other sciences. An insufficiently informed person might regard astrophysics, stellar interiors and galactic structure as esoteric and arcane intellectual exercises. The truth is that basic principles which were first discovered in the study of the stars and nebulae have very often provided the direct lead for important advances in physics and other sciences.

One does not have to look far for examples of the lead provided by astronomy: the discovery of nuclear reactions as the source of stellar energy pointed the way for their utilization on earth; again, the success of the very-long-base-line radio observations of Quasars (first achieved by a Canadian group) now offers a means of measuring intercontinental distances with an accuracy undreamed of before; as another example, astrophysical investigations of plasmas have opened up a whole new field of laboratory studies of this "fourth state of matter" which could have importance almost beyond imagining.

Today's astronomy is very often tomorrow's physics and next week's engineering.

Unless this fact is realized fully by those who formulate Canada's science policy, we fear that Canadian physical scientists may be relegated to a degrading one-lap-behind position in world science and technology.

Basic scientific research, which most certainly includes astronomy, must have strong support from public funds.

4. CANADA'S POSITION IN ASTRONOMICAL RESEARCH IS THREATENED

Until now Canadian observational astronomers, supported by three excellent optical telescopes at two major observatories and two excellent radio telescopes, by skilful designers of auxiliary equipment and by a few brilliant theoreticians, have maintained an internationally recognized position of excellence. Although these optical telescopes

can still be used for major researches, the frontiers of astronomy are, in many cases, beyond their reach. Some Canadian astronomers have been able to work as guest investigators at the more fortunately endowed American Observatories, but these opportunities may soon be withdrawn. It is essential that first-class observational facilities be set up for present and future generations of Canadian astronomers.

To satisfy the needs of all Canadian astronomers a large telescope in Canada and a share in a southern-hemisphere observatory have been requested. The total cost of these is small relative to the multi-million dollar projects required in other fields of science. They would meet the expanding needs of both university and government astronomers in this science which indeed looks out upon the universe.

5. UNIVERSITY AND GOVERNMENT ASTRONOMY COMPLEMENT EACH OTHER

Both universities and government institutions have roles to play in astronomical research. To the universities belongs the role of teaching not only the astronomers of the future but physicists and other scientists who require a knowledge of modern astrophysics; to do this well involves research on the part of both teachers and students. To astronomers in government institutions belongs the role of the sustained acquisition of basic information, long term projects less suited to the nature of universities. It must be possible for both groups to work together sharing the same equipment.

6. AN ASTRONOMER ON THE SCIENCE COUNCIL

In order for the Science Council fully to understand the importance of astronomical research in Canada's Science Policy, and in order for it to be in a position to understand and bring to fulfilment the urgent needs of both university and government astronomers, we strongly urge that an astronomer be appointed to the Science Council.

4 March, 1969.

APPENDIX 217

CANADIAN ASSOCIATION FOR EDUCATION IN THE SOCIAL SERVICES

151 Slater Street,
Ottawa 4, Ontario.

BRIEF TO THE SENATE COMMITTEE ON SCIENCE POLICY

ABSTRACT

The Canadian Association for Education in the Social Services represents the interests of university schools of social work. The association's brief deals with the present state of research in Canadian Schools of Social Work, with the consequences of the state of research and, with science policy and the state of research. A state of underdevelopment is contrasted with the large public stake in welfare matters. Measures urged to rectify this situation include proposals for science policy, for funding, for the development of regional centres, for a long term perspective and for the relationship of the social sciences to social work.

BRIEF

INTRODUCTION:

1. The Canadian Association for Education in the Social Services, (CAESS) is the national body dealing with professional university education for social work and social welfare. The ordinary membership of CAESS consists of all Schools and Departments of Social Work in Canadian Universities. There are 16 such schools or departments, 4 using French as the principal language of instruction and 12 using English. CAESS maintains a permanent secretariat located at 151 Slater Street, Ottawa.

2. The objectives of CAESS as stated in its by-laws, include the representation of "the collective interests of members in relation to other educational, professional, learned, welfare or public bodies, whenever collective expression is desired".

3. The interests of its members are vitally affected by the issues being discussed in the current debate on science policy. CAESS thus welcomes the opportunity to make this submission to the Special Committee on Science Policy.

4. CAESS is not in a position to offer a global view of science policy. It recognizes that it views but one sector of a large field. That sector is the research conducted by Schools of Social Work in universities.

5. Research in Canadian Schools of Social Work deals with social problems, social policy, social work and social work education. In none of these fields does it have an exclusive role. Social scientists in the academic disciplines have also given attention to social problems and social policy. In addition, research in these fields has been undertaken by the research divisions of federal and provincial welfare agencies, by community social planning councils and, most notably, by the Canadian Welfare Council. However, the research and scientific interests of schools of social work are distinct. Distinct, on the one hand, from the social sciences in the emphasis placed by the schools upon studying the situations leading to social intervention, the means of social intervention, (both individual and programatic) and the results of social intervention. Distinct, on the other hand, from such bodies as the Canadian Welfare Council's Research Division by their university setting. The university setting emphasizes excellence in scholarship, the pursuit of knowledge as an end in itself, and the complementary relationship of research to teaching.

6. These distinct interests provide members of CAESS with a unique perspective that directs attention to the large issues with which the Special Committee on Science Policy is concerned, and which leads to some specific recommendations.

THE STATE OF RESEARCH IN CANADIAN SCHOOLS OF SOCIAL WORK

7. The beginnings of research capacity exist in the Schools of Social Work. Individuals with pertinent interests and ability are on the faculties of the schools. Prospects of significance have been carried by the graduate schools and the objectives of the schools include the promotion of research and the extension of science. However, there is a lack of systematic development. Symptomatic of that lack of development is the fact that there is only one Canadian university, the University of Toronto, that offers a doctoral degree in social work and only one Canadian university, again the University of Toronto, in which the school of social work is developing a university research institute dealing with welfare problems.

8. Instead of concerted research activity in a few centres, there is a scattering of individuals with some research interest and ability throughout the Schools of Social Work.

This inevitably produces a scattered pattern of research activity. Research activity tends to be dependent on the private interests of particular individuals and tends to lack co-ordination or continuity.

9. Dean LeClair of Sherbrooke told the Special Committee on Science Policy that all faculties of medicine in Canada would have to close, for reasons of incompetence, if the Medical Research Council were to stop its financial assistance to research. There is no parallel to the Medical Research Council to whom schools of social work can look for the support of social research. Schools of social work face problems in funding research, particularly in supporting research careers by faculty. In practice, schools are not able to offer faculty members research appointment, or even offer them appointments that allow them to give a substantial part of their time to research. Faculty members' duties are principally teaching and administration.

10. The Canada Council has not been active in this field. There are two reasons for this. First, the Canada Council has adopted a passive role, awaiting applications. The field being underdeveloped, few applications have been produced. Second, the Canada Council is oriented primarily to the support of the academic social science disciplines rather than to the support of such professionally identified disciplines as social work.

11. Proposals contained in Special Study No. 7, "The Role of the Federal Government in Support of Research in Canadian Universities" (the MacDonald Report), prepared for the Science Council of Canada and the Canada Council, do not directly address the dilemma faced by social work and welfare research in the universities.

The first recommendation of that report that "Federal research councils, be organized in such a manner that, when taken together, their terms of reference will encompass all disciplines recognized by the Canadian universities" is not fulfilled, in relation to social work, by the proposed three council structure. Social work is not a health science and would not be able to obtain support from the proposed Health Sciences Research Council and, as a professional discipline, it is unlikely that it would be accepted as a social science and supported by the proposed Humanities and Social Sciences Council. Social work would probably have to relate to the proposed Inter-council co-ordination Committee. That body would not appear to offer a basis for the stimulation and long term development that are urgently needed.

12. Some support for welfare research has come from Canadian Foundations. However, the major source of funds for university research in the fields in which schools of social work have been active, has been the mission oriented agencies of the federal and provincial governments. The most active support has come from federal agencies, in particular, from the Welfare Grants Division of the Department of National Health and Welfare.

13. The purposes of the welfare grants program (initiated in 1962), included the resolution of the problem of the almost complete absence of applied research in the welfare field. \$500,000. is appropriated annually for research projects funded through this program. In fiscal 1968-69, expenditures totalled \$410,825. Of this amount, \$130,400. was expended in the universities, \$80,307. in schools of social work and \$50,102. in other university departments. This expenditure represents a significant increase in the amount of funding for welfare research as compared to the pre-1962 situation.

However, this expenditure has not resulted in any consistent pattern of development of university capacity for research. There are three reasons for this:-

(i) Expenditures have been made on a project by project basis. The purpose of the project has been the primary criteria for its acceptance. This is understandable in a mission oriented agency but it does not provide consistent support to university research as an activity in its own right.
(ii) The practice of the Department of National Health and Welfare has been to restrict its funding to the direct costs of research. Indirect costs. space, equipment, administrative overheads have not, usually, been covered. This means that these costs must be covered by the University. While a School or Department only conducts one or two projects, these costs can usually be absorbed, but as the number of projects conducted in one centre grows, these costs become considerable. They require explicit recognition. The failure to recognize indirect costs tends to keep projects scattered.
(iii) The effect of project by project support and the absence of coverage of overhead costs means that the universities cannot offer a research career line.
For these reasons, the welfare grants program has failed, in 7 years of operation, to produce significant advances in the capacity of the university schools of social work for research.
14. Finally, the quality of research in schools of social work has suffered because of the isolation, within the university, of most social work programs. This is partly because social work cannot be integrated into the jurisdictional pattern of social science disciplines. Social work, in effect, lays claim to the whole field of social science, organizing its interest in that field around the special focus of professional roles and professional intervention in the social services. A broad claim to the fields of several academic disciplines and a professional focus are recognized in the special administrative status accorded within the university to social work - social work is usually studied in schools, not faculties or departments.

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This special status has often involved separation from the mainstream of university study and from substantial interaction with the social sciences in research. There are signs that this separation is ending. The Schools of Social Work are seeking closer relationships with the social sciences and the social sciences are showing increased interest in social problems and policy.

15. The public stake in the fields of study, in which schools of social work should have the capacity for substantial research, is large. The annual expenditure in Canada for income maintenance alone exceeds $3 Billion. In addition, professional social workers occupy key roles in the fields of child welfare, family planning, rehabilitation, corrections, mental health, community development, social planning and housing.

16. The absence of substantial university based research has serious consequences, both, direct and indirect. The direct consequence is a lack of good quality information on social problems and social policy, and an absence of the stimulus to professional debate that information and new conceptual approaches produce. The indirect consequence is that education for the key professional leadership roles in the social services tends to occur in a non-scientific atmosphere. The quality of the next generation of professional leaders in the field of the social services needs to be raised. The development of university based research in the welfare field would, in conjunction with other measures, raise the standard of social service education and, hence, the quality of professional leadership.

SCIENCE POLICY AND THE STATE OF RESEARCH

17. It would appear that the absence of an overall science policy is a major reason for the lack of development of research in schools of social work. On the one hand, the fields requiring study are crucial to the functioning of our society; on the other hand, the resources and capacity do not exist and no new steps to promote their existence are being contemplated.

18. Science policy needs to be viewed in a comprehensive way. Science policy and national purpose are closely related. Science policy needs to be conducted according to the priorities of a conceived set of national purposes. Amongst those purposes there is a need for stimulus both, to research concerned with particular problems and, to research to add to knowledge as an end in itself. All sectors of national endeavour require both these types of stimulus. A function of any comprehensive science policy should be to survey the fields of national endeavour to locate areas where, for reasons of history, capacity or jurisdiction, this stimulus is lacking.

19. Social welfare and social work research is one field in which the stimulus is lacking. Overcoming this situation requires action in several areas.

20. A counterpart of the medical research council is urgently needed for the field of social research. An adequatelv funded body aiming to promote knowledge, through research, of social problems, policy and interventions needs to be brought into existence. Such a body would complement the research interests of the mission oriented agencies by providing support for welfare research as an end in itself.

21. A policy of strategic development of regional centres for the study of welfare and allied problems needs to be promoted. Such a policy would aim to produce concentrations of expertise and research ending the present scattered pattern. The sizeable units created would be able to offer continuity in studies. They would provide a career opportunity for research workers. They would represent a resource to the mission oriented agencies, both provincial and federal, and they would serve to stimulate social service education.

22. A long term perspective needs to accompany such a concept of strategic development. Goals are needed for research capacity in this field for 10 years hence. Expditures then need to be organized to obtain these goals. Expenditures should not be made purely in terms of funding particular projects of current interest.

23. The jurisdictional separation of social work from the academic social science disciplines must be overcome. As noted earlier in this brief, there are signs that the separation is ending. Welfare research capacity can best be developed through a partnership between the social sciences and social work. The promotion of this partnership should be an objective of science policy.

APPENDIX 218

BRIEF ON SCIENCE POLICY

Submitted to

THE SPECIAL COMMITTEE ON SCIENCE POLICY

of

THE SENATE OF CANADA

by

The Chartered Institute of Secretaries of Joint Stock Companies
and Other Public Bodies in Canada

Head Office: Montreal
National Office: Toronto

SUMMARY OF RECOMMENDATIONS

1. THAT formation of science policy give careful consideration to the effects of science and technology on Canadian management skills and their importance in ensuring a satisfactory rate of economic growth and the maintenance of a competitive position for Canada in world markets.

2. THAT the Science Council be enlarged to provide for broader representation of scientific activities on the part of crown corporations, provincial governments, the universities and private enterprise; and THAT, if a principal purpose of science policy is to achieve overall coherence, the leadership in implementing proposals be taken by the Government of Canada.

3. THAT the science library of the National Research Council be expanded and established as the National Science Library.

4. THAT consideration be given to establishing at an appropriate time a Ministry of Science to advise and report to Parliament on scientific activity in Canada.

INTRODUCTION

5. The Chartered Institute of Secretaries is a professional organization of executive administrators. Science, therefore, may seem peripheral to our interests; but modern industry is based on science and technology. Indeed, because so much of modern administration has become machine-oriented, and characterized by sophisticated and changing techniques, we are deeply concerned about what the executive should know and learn to become a competent administrator.

6. We must leave to the agencies actually engaged in scientific research and related teaching the submission of information covering what is now being done in such fields. However, having regard to your object of formulating a suitable organizational structure for a science policy, and on the assumption that a fundamental purpose should be to achieve overall coherence of Canadian efforts therein, we would make the following suggestions:

Recommendation No. 1 on

MANAGEMENT SKILLS

7. In The American Challenge, J. J. Servan-Schreiber, after stating that Europe may be "witnessing the prelude to (its) own historical bankruptcy", goes on to say: "In trying to understand why this is so, we stumble across the key element. This war -- and it is a war -- is being fought not with dollars, or oil, or steel, or even with modern machines. It is being fought with creative imagination and organizational talent."*

8. Some Canadian scientists have advocated Canadian competition in space exploration, mainly on the ground that it would produce proliferation of new industries. Admittedly, pure research may produce useful information for practical applications. Moreover, defense research may produce better-equipped laboratories and better-trained scientists, as well as encouraging more research, mainly because sufficient money becomes available. It is also true that space research may produce new industry, and in the United States it has stimulated existing industry. However, as Servan-Schreiber has stressed, the critical issue is "not a question of money"** but of developing management skills.

9. If science and technology prove as transforming to our society in the next decade as in the last, and we see no reason why they should not be, Canada will surely need all the creative imagination and organizational talent at her command if she is to hold her own in the "post industrial society" that Servan-Schreiber envisions.

10. As electronics and sophisticated machinery assume more of the work load in commerce and industry, the need for more and better-trained managers becomes imperative. Scientists and technologists, as specialists, are able to function well without knowing a great deal about administration. On becoming senior executives, however, they are likely to face managerial problems that are overwhelming unless they have adequate knowledge of modern administrative methods.

* The Introduction, Page xiii
** The title of Chapter 2

11. Two basic problems are involved: first, the creative imagination needed to "manage" science policy itself; and secondly, the action necessary to increase and improve management skills of individuals. With respect to the former problem, the implication is that science policy should itself be managed. We believe it should be managed on an assumption that it will affect the welfare of all our people in a variety of ways. As for the latter problem, the "capital fund" of managers the nation requires will never be sufficient. In this context, "intelligent use of skills" compels planning, organization and control.

12. "In America today the government official, the engineer, the scientist have joined forces to develop co-ordinated techniques for integrating factors of production. These techniques have stimulated what amounts to a permanent industrial revolution. The Americans call it 'cross-fertilization'. The originality of this revolution consists precisely in the effect this fusion of talents has on decisions made by government agencies, corporations and universities. This takes us a long way from the old image of the United States -- a country where business was not only separate from government but constantly struggling with it, and where there was a chasm between intellectuals and businessmen. Today, to the contrary, this combination of forces has produced the remarkable integrated entity that John Kenneth Galbraith calls a 'technostructure'."*

13. As Canada is a continental neighbour of the United States, the challenge may be as direct and pertinent to us as it is to Europe. Regarding the extent to which "cross-fertilization" has already occurred, we do not venture an opinion, but we would be reasonably confident on these points:

(a) If a Canadian "technostructure" is to be established it will require co-operation of all important segments of our society.

(b) If the prerequisite organization and integration of science policy are to occur, the Government of Canada should provide the leadership.

(c) If more sophisticated use of skills is a key to progress, more attention should be directed to the incidence of science and technology on management, and more effort devoted to the development of management skills.

* The American Challenge. Pages 27 and 28.

14. We are cognizant of the heavy financial burden that education entails for governments and the taxpayers. We note and welcome the developments, particularly in recent years, of colleges of fine arts and technology and the community college. We recognize that Canadian educators are capable and concerned about the nature and quality of Canadian training, and that new concepts have already been implemented or are planned. We believe that our universities are making an impressive contribution and a commendable effort to meet onerous and rising demands on their facilities. Moreover, their administration and faculty members face a wide range of problems, not the least of which is to create a new milieu for institutions inhibited by tradition and limited physically by plant and space. We are also aware that curricula are being scrutinized for adequacy in meeting the needs of a changing society. Furthermore, we know that the private sector has made a significant contribution to the production of skills through in-plant training programmes usually designed to meet the requirements of individual enterprises. Nevertheless, education viewed in the context of the vital importance of management skills to our future will demand greater relevancy between training and its applications in business and government. Also imperative will be the more effective allocation of scarce resources of both money and talents and this implies greater coherence or co-ordination of efforts -- particularly among governments. In our view, such an emphasis will be needed before existing gaps in our educational system can be filled. In the context of the important role of education in the development of management skills, we suggest that priority consideration be given to the following:

(a) A feasibility study on the nature and extent to which the Government of Canada should underwrite programmes designed to develop management skills in co-operation with the provincial governments, educational institutions and private enterprise.

(b) Encouragement of private enterprise and the professional organizations seeking to meet the rising demands for business and public administration training to co-operate more fully in providing such training and in offering practical experience in administration. Among other things, this will involve the development of training syllabi of greater relevance for modern management.

(c) Emphasized development of more uniform standards in the teaching of science at the university level.

Recommendation No. 2 on

COHERENCE, CO-OPERATION AND LEADERSHIP

15. We believe the establishment by the Government of Canada of this Special Committee of the Senate on Science Policy is a most constructive development, and are also pleased to note that the Science Council for Canada has been set up as an independent adviser to the government with the same status as the Economic Council of Canada.

16. It is often difficult for management to make a valid judgment on whether centralization or decentralization is the more desirable; and the same holds true for coherence in scientific activity. For instance, the recent decision to place the Medical Research Council under the Minister of Health and Welfare has the logic of related activity to justify it. We believe, however, that the question is not so much either that centralization takes place for science activity or it does not as it is to begin with a centralized authority and made adequate provision for co-ordination of decentralized activities. It may be possible for growth in science to take place while regulated and encouraged by a number of authorities and agencies. However, we favour a concept of centralization because the challenge of the future to Canada will obviously require a high degree of coherence and co-operation of the participants. Moreover, we should not expect a satisfactory result from science projects carried on in an environment characterized by disparate and unco-ordinated activities.

17. The Institute would also like to have two other points given adequate recognition; namely, if science policy is to be valid, its terms and conditions should be explicit and its implementation should be governed thereby, also

to be effective such policy should be revised and modified as conditions change. To popularize this concept, and to indicate how it might be put into operation, we suggest the following:

(a) That the Science Council absorb the National Research Council, and that the structure of organization comprise four directorates:

(i) Planning and Finance

(ii) Government

(iii) Private Enterprise

(iv) Education

(b) That each directorate maintain liaison with scientific effort in its own field; and that the Council represent the interests of the four directorates, reporting to Parliament through an appropriate Ministry on matters affecting the national welfare. Its budgetary estimates and policies should be subjected to parliamentary debate and scrutiny.

(c) That a Fund for Science be established, containing a general fund and separate funds for each of the four directorates.

(d) That the Fund for Science be administered by the Council; that the Council itself comprise Commissioners who would determine priorities for science projects and attempt to eliminate duplication in science effort; that expenditures be made in particular areas mainly on the recommendation of the directorate affected.

(e) One of the principal aspects of implementation is financing. Although initial federal expenditure is contemplated, the concepts noted above envisage a shared basis for the financing of science projects by governments (Federal and Provincial) and by private enterprise. Contributions from the latter will likely depend to a considerable extent upon the degree to which corporate enterprises may wish the Science Council to conduct basic and applied research on their behalf.

(f) That the Commissioners of the Council direct special attention to four areas involving all directorates:

(i) Matters requiring political decisions or legislation;

(ii) Training (or education) necessary for the furtherance of Canadian science, with particular reference to the development of management skills;

(iii) Research in person-to-person communication;

(iv) Effective liaison between the Council and all parties engaged in important scientific work in Canada;

(v) Careful interpretation of science policy as determined from time to time by the Council to the relevant bodies that will be engaged in implementation of such policies.

(g) That staffing relations be developed along the following lines: The Public Service Commission of Canada provide staff for the Planning and Finance Directorate, and for the Government Directorate, in consultation with the Civil Service Commissions of the provinces on the basis of giving adequate representation to each province. The Public Service Commission consult such bodies as The Canadian Chamber of Commerce and the Canadian Manufacturers Association on appointments for the Private Enterprise Directorate, and the universities and the other educational bodies on appointments to the Education Directorate. As noted above, the National Research Council staff could provide the nucleus for research activity, basic and applied.

(h) That the Planning and Finance Directorate be responsible for office administration for all directorates.

Recommendation No. 3 on

NATIONAL SCIENCE LIBRARY

18. We suggest that consideration be given to establishing a National Library of Science in Ottawa, independently of the National Research Council or the Science Council for Canada. It is contemplated that such a library would provide services on a fee basis to those engaged in science projects or citizens interested in scientific data. The Technical Information Service of the National Research Council could also become an independent activity, although attached to the National Library of Science.

Recommendation No. 4 on

A MINISTRY OF SCIENCE

19. Consideration should be given to the creation of a Ministry of Science. If a full-scale department is not feasible at the outset, the Science Council for Canada could report to Parliament through one of the existing departments.

20. Science and technology are wide-ranging both in activity and in implications for the future of our nation. A successful science policy in a country such as Canada, in the opinion of the Institute, will require an unusual degree of co-operation among all interested participants. To achieve such co-operation, it will be necessary to develop an organizational structure, both representative and functional. Such a structure in our opinion can be erected more effectively through the creation of a Ministry of Science.

21. All of which is respectfully submitted.

APPENDIX "A"

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of

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APPENDIX 219

SENATE OF CANADA - SCIENCE POLICY

A BRIEF TO THE SENATE OF CANADA'S SPECIAL COMMITTEE ON SCIENCE POLICY

January, 1969

FROM: Members of the Prosthetics/Orthotics Research and Development Unit
Sanatorium Board of Manitoba
Rehabilitation Hospital
800 Sherbrook Street
Winnipeg, Manitoba

Participants in the Brief:

Dr. F. R. Tucker, M.Ch. Orth. (Liv.), F.R.C.S., (C. & Edin.), Medical Director
Mr. J. Foort, MASc., Technical Director
Mr. I. Cochrane, Engineering Technician
Mr. R. Daher, BSc., Design Engineer
Mr. P. Nelson, BSc., Research Assistant

SUMMARY

1.1. A science policy for Canada should put greater emphasis on the use of research results through the support of applied research, development and innovation programmes.

1.1.2 The fields in which we are engaged will demonstrate the value of this approach. Where there was previously stagnation, we have, with rather small funds for the purpose, and within five years, breathed in new life. Our programme, dealing with applied research, development and innovation, coupled with the necessary amount of education required to transfer findings to others who will apply the results, has been in the fields of prosthetics (artificial limbs) and orthotics (braces). These fields are too small to attract private enterprise and must be supported out of public funds.

1.1.3. We feel that there is a wealth of information available in the world for the solution of human problems. Canada's science policy must be realigned to exploit this information.

The key to this is the utilization of key professionals in programmes designed to this end. Best results would accrue if long term support were given to such professionals to work out programmes identified as appropriate by Ad Hoc committees. These professionals would then be given project grants (one to five years) for implimentations of these programs.To ensure the necessary sympathy at the Grants Committee level, there would have to be senior professionals who have a flair for applied research, development and innovation on these committees.

1.1.4. We find support for these views in Report Number 4, "Toward a National Science Policy", by the Science Council of Canada.

COMMENT: It is ironic that Germany and Japan, smashed by war, should have risen to such heights, while Canada, flushed with productive capacity, turning out large groups of technical people, sitting on mountains of resources and blessed with a relatively small population, has made less significant advances.

2. INTRODUCTION

2.1. The Prosthetics/Orthotics Research and Development Unit was established in 1963, along with sister units in Montreal, and Toronto, as an aftermath of the Thalidamide event. The Bio-Engineering Institute, University of New Brunswick, so named in 1965, has been established since 1960.

2.2. Prosthetics is the field of artificial limbs. Orthotics is the field of bracing. Many of the problems of disabled people requiring artificial limbs and braces cannot be solved except through the application

of public funds, because the fields are relatively small and there is no private sector robust enough to deal with these problems.

2.3. Problems in the fields of prosthetics and orthotics in Canada hinge on the facts that:

I. Funds provided are given for fundamental research rather than for applied research, development and innovation.

II. There is no industry for the fabrication and and distribution of modern components. It must be pointed out in this regard that the D.V.A. facilities have proven lacking til now in this regard. They have failed to vigorously upgrade their staff; failed to attract high quality staff through adequate remuneration; they have had a military-like organizational structure; they have been committed to a stabilized system of prosthetics and orthotics rather than to a dynamic and evolutionary process of improvement and they depend on aging staff.

III There is no formal education programme, except that established in Montreal for the education of technicians for their services.

IV There has not been, and there is not likely to be, a national body of the type required to take the fields of prosthetics and orthotics under wing, apart from the research groups

in Winnipeg, Toronto, Montreal and New Brunswick.

V Those of us who have demonstrated an advanced view realize what is possible in the fields of prosthetics and orthotics. However, to see the possible established as reality, we will require better support. We now find ourselves bound nationally to a grant total of approximately $250,000 for the four programmes as compared to grants totalling $4,500,000 in the United States. It may seem that the total is not so disproportionate on a per capita basis. But in fact, government support in these fields in the U. S. A. has been given for over twenty years, often on a scale larger than at present, while in Canada, support is quite recent. Some of the $4,500,000 benefits Canada since the Canadian units are closely allied with their American counterparts in design and development activities. (N.B. - Mr. C. A. McLaurin, Ontario Crippled Children's Centre, Toronto, and Mr. J. Foort, Manitoba Rehabilitation Hospital, Winnipeg, came back to Canada from American Programmes in 1963).

2.4. Because we of the research and development units are mission oriented, we have suffered the darts of grantors who are less familiar than we with the actual needs. Their bias is for research. They believe that research is what we should be doing.

2.5. The truth of the matter is that research is less needed than design and development. Education is needed. There is a great deal of information already available. Outside of these units, there is no mechanisms for exploiting it. It is our belief that strong development and education programmes will bring into being appropriate designs for modern services, teach clinical people and manufacturers how to use available information and help organize the system of services needed for the best use of modern communication and distribution techniques.

2.6. Some of the points we make in this Brief are what seem important to us on the basis of our experience in carrying out a programme for the improvement of prosthetics and orthotics in Canada. We feel that improvements in other fields, even when the scale is different, may rest on similar ideas.

3. MAIN POINTS

3.1. GREATER USE SHOULD BE MADE OF AVAILABLE FUNDAMENTAL INFORMATION FOR THE SOLUTION OF HUMAN PROBLEMS:

3.1.1. Although the three sister units are classified as research units, the need is not so much for research as for utilization of existing knowledge for the development of better solutions. One problem is that others who might want to contribute are not easily able to because much of the information we use is in our heads (accumulated through years of experience) and other data are not easily available or in useful form.

3.1.1.1. RECOMMENDED: That fundamental information be made more available through the use of modern storage and retrieval systems on a national scale.

3.1.1.2. RECOMMENDED: That those with special knowledge be given the means to put this knowledge in more useful form.

3.1.1.3. RECOMMENDED: That support be given to scientific "Jacks of all trades" who would aid in integration of the sum total of scientific knowledge.

3.2. IN SOLVING HUMAN PROBLEMS, THE AIM SHOULD BE TO HAVE EFFECTS BEYOND THE FIELDS IN WHICH THE PROGRAMMES ARE CARRIED OUT:

3.2.1. What we do in our fields, is to carry out education programmes at the same time as we proceed with design and development work. In this way, others are recruited to be "with" us in fostering evolution of our progressive ideas and they are prepared for application of the new ways.

3.2.2. We have used our design ideas to develop Canadian capabilities for the production of the new designs. These new designs not only come from us, but also from developers and designers anywhere in the world. We have seen ourselves in the embarrassing position in the past of having to import items originally conceived in Canada. In addition to the specific items which have been introduced into Canadian industry, we have also been able to introduce new technologies

and improve ones already in use. By the encouragement of production of Canadian designs and of designs originating outside the country, there is a possibility that we can develop a home industry for the production of most of what we need in the fields of prosthetics and orthotics and in addition, develop an export potential.

3.2.3. We have, with our sister units in Montreal, Toronto and New Brunswick, encouraged the organization of the clinical people (who are potentially the users of our solutions) so that we can have the benefit of their support and guidance.

3.2.4. We have involved ourselves in programmes outside the country, mainly in the United States, so that their results would be open to us and ours to them. At the same time, we can guide each other and reduce duplication.

3.2.1.1. RECOMMENDED: That funds be supplied in such a way that the researcher or developer can teach prospective users what he has learned.

3.2.2.1. RECOMMENDED: That funds be supplied in such a way that the researcher can teach prospective producers what he has learned.

3.2.3.1. RECOMMENDED: That the potential user of the solutions of investigators be organized to assist through field testing and advice.

3.2.4.1. RECOMMENDED: That where possible, projects and programmes be integrated with what is going on in other countries.

3.3. <u>FUNDS USED FOR THE SOLUTION OF HUMAN PROBLEMS SHOULD BE APPLIED TO OBTAIN THE BROADEST EFFECTS GEOGRAPHICALLY (NATIONAL AND INTERNATIONAL, RATHER THAN LOCAL)</u>

3.3.1. We encourage others to field test our designs and development items so that they will learn of the desirability of participating in our programme. For this, funds are needed which can be used to purchase the small numbers of field test items with which to prime the pump. Sometimes the procurement of items from others is needed so that ones own designs can be compared and their designs can be tested. This helps to undermine the "best if designed here" attitude. Large scale field testing should be supported out of separate funds in the hands of potential users. This would help to sift out premature items or faulty designs, since the user would be interested primarily in those which represent the best solution to the problem.

3.3.1.1. RECOMMENDED: That funds be included in research and development grants for the procurement of models, prototypes and small field test quantities of items developed.

3.3.1.2. RECOMMENDED: That funds be provided apart from research and development grants for procurement of larger field test quantities to be produced by potential users.

3 4. <u>EXPOSURE OF PEOPLE IN DIFFERENT DISCIPLINES TO ONE ANOTHER SHOULD BE ENCOURAGED:</u>

3.4.1. Access to existing skills is often a problem. The skills needed in addition to those possessed by the researcher, designer or developer, can often be obtained by going to the source more cheaply than if the investigator must learn them for himself. Even when it is known where the skills are, it is often not possible to have access to them because funds are not available for this particular purpose.

3.4.1.1. RECOMMENDED: That funds be provided within research grants or in special grants for investigators to easily visit others who may aid in the solution of their problems.

3.4.1.2. RECOMMENDED: That funds be provided within the research grants or in special funds for investigators to purchase special skills needed for the most expeditious solution of their problems.

3.5. <u>GRANTS SHOULD BE PROVIDED OVER A SUFFICIENT TIME SPAN TO PERMIT CONTINUITY IN PROGRAMMES AND TO ALLOW THOSE INVOLVED TO PUT DOWN ROOTS IN THE COMMUNITY:</u>

3.5.0.1. RECOMMENDED: That grants be made for periods of up to five years in duration, depending on the nature of the problem.

3.6. <u>GRANTS SHOULD BE MADE SUFFICIENTLY FLEXIBLE THAT WHEN A STUDY COMES TO A HEAD SUDDENLY, THERE IS A POSSIBILITY FOR ADDITIONAL FUNDS OR THE DIVERSION OF FUNDS TO DRIVE IT THROUGH:</u>

3.6.0.1. RECOMMENDED: That on the strength of evidence, funds

which would normally be made available at a future date, be available immediately when a break-through is effected in a project or programme.

3.6.0.2. RECOMMENDED: That funds accumulated because of thrift or a changed pace in research and development work, be transferrable to the next year.

3.6.0.3. RECOMMENDED: That additional funds be provided when they will obviously bring a study to a head sooner with the prospects for overall savings and advanced applications to the solutions of human problems.

3.7. GRANTS SHOULD BE MADE AVAILABLE FOR THE SUPPORT OF COMPLETE PROGRAMMES AS WELL AS PROJECTS SO THAT ALL ASPECTS OF CERTAIN ENQUIRIES CAN BE PURSUED SIMULTANEOUSLY. THIS WILL ALLOW THE VARIOUS ASPECTS RELATED TO ONE ANOTHER TO BE KEPT IN PHASE:

3.7.1. Is knowledge for knowledge sake always legtimate? Should not there be less fragmentation of investigations so that the broader ramifications of what is undertaken can be seen? In the prosthetics programme, we have had to carry on development work, limited field testing, education and modification to designs simultaneously. At the same time, we have had to concern ourselves with the production problems because of the new materials and techniques we required for our designs. This has been possible under the Health Grant we have received, although we have had static from "above" because the testing we have done has involved some expenditures on providing test

prostheses for amputees. This has been called treatment. Should we merely design, record our designs and pass on without testing their validity? This procedure has been tried in the past, only to see the designs sink into oblivion and finally to be revived again as "new ideas".

3.7.1.1. RECOMMENDED: That programme grants leave the investigators a great deal of lee-way.

3.7.12 RECOMMENDED: That people receiving programme grants be required to outlined the relevance of what they wish to undertake to human problems and to show the relationships between the various aspects.

3.8. PERFORMANCE IS MORE IMPORTANT THAN ACADEMIC QUALIFICATIONS:

3.8.1. We have all seen situations where the contributions of some team members in research or development programmes is not recognized in terms of their status. This is shown by their salary scale. Also, men of ability are not always given a chance to participate becuase they do not have the necessary "handles" attached to their names which would ensure them a hearing.

3.8.1.1. RECOMMENDED: That grants be given to gifted individuals who have a particular bent regardless of their academis standing.

3.9. WHEN GIFTED PEOPLE APPEAR AND SHOW AN INTEREST IN A PARTICULAR FIELD, THERE NEEDS TO BE MEANS AVAILABLE FOR INVOLVING THEM IN THE FIELD:

3.9.1. Right now, there is little recognition of the fact

that Engineers could make important contributions to rehabilitation of the disabled at the treatment level. There is the need, but the recognition is only slowly developing. We have encouraged young Engineers into our programme. When the need is recognized, we will have men ready to fill it, unless lack of insight at the grantor level snuffs us out prematurely.

3.9.1.1. RECOMMENDED: That special funds be established for taking in gifted men who can be used to improve existing programmes and can be held to meet needs when they are finally recognized.

3.10.1.1. PROGRAMMES WHICH CANNOT BE HANDLED ON A FREE ENTERPRISE BASIS BECAUSE OF LOW PROSPECTS FOR RETURNS, OR THE ABSENCE OF IMMEDIATE RETURNS, SHOULD BE DEALT WITH OUT OF PUBLIC FUNDS ON A LONG TERM BASIS:

3.11.1. Developments in prosthetics and orthotics fall into this catagory. Also, there is no liklihood of new designs being developed in Canada outside such programmes as ours which are supported by public funds. Even when public funds are being used to carry out treatment, as in the original D.V.A., the prospects for getting development of excellent new designs is limited because of pressure of immediate needs and the strong impulse to stabilize procedures and designs. As a result, what passes for stability is often more like stagnation. The results obtained by the more independent research and development units on the other hand, have enlivened people at the treatment end so that they would now like treatment units which are tuned in to these programmes.

3.11.1.1. RECOMMENDED: Selected programmes for the solution of human problems should be designated as long term programmes for support purposes.

3.12. YOUNG PEOPLE SHOULD BE ENCOURAGED TO "LIVE" WITH ACTIVE RESEARCHERS, DEVELOPERS AND DESIGNERS AS PART OF THEIR EDUCATION AND TO GIVE THE EXPERIENCED PEOPLE ACCESS TO THEIR NATURAL ENTHUSIASM, ENERGY AND IMAGINATION:

3.12.1. Many outstanding people have done their best work when young. Nowadays, when so much of young person's life is tied up with getting a formal education, he has insufficient opportunities to face real problems which will tax his knowledge and native ability. In Winnipeg, we have had a number of young Engineering students who have completed their third year, join us for the summer. They then used their new experience as a basis for their theses. We have taken some of them on staff. The others will always remember their experience with pleasure, and may, at a later date, when the need arises, come back to a similar project. We have also encouraged Physiotherapists in a similar way midway through their training. Some of them have become specialists in prosthetics and are now engaged in treatment work. How much better is this than having them do construction work for money.

3.12.1.1. RECOMMENDED: That funds be included in research and development grants for hiring students on research and development projects and programmes between terms.

3.12.1.2. RECOMMENDED: That funds be made available through these projects and programmes for sub-

sidizing students who show promise and who are willing to continue to contribute through the year.

3.13. A PROGRAMME SHOULD BE SPONSORED BY GOVERNMENT WHICH OPENS NATIONAL PROBLEMS FOR SOLUTION BY CITIZENS IN COMPETITION OR THROUGH "THINK TANK CLUBS":

3.13.0.1. RECOMMENDED: That funds be made available for rewarding citizens who win competitons for the solution of problems of national significance.

3.14. THE SCIENCE COMMUNITY SHOULD BE ORGANIZED FOR DYNAMIC INFORMATION EXCHANGE FROM THE "PURE" RESEARCH LEVEL TO THE MANUFACTURING AND DISTRIBUTION LEVEL:

3.14.1. Each person becomes so involved with his own interests and nitch that he is isolated from what is going on elsewhere. Often information gained in one area is of value in another, but because the areas seem unrelated, the information is not diseminated broadly enough to break the barrier. What is needed is a publication which will bridge such barriers. Perhaps there should be a "Scientific Canada" magazine which would be attractive to people over a wide range of interests and spark their comments. The editors of such a publication would be "Science Ombudsmen".

2.14.1.1. RECOMMENDED: That the possibilities of a Scientific Journal of an interdisciplinary nature be explored through the various associations representing sciences and technologies.

APPENDIX 1

ABOUT THE WINNIPEG RESEARCH UNIT

Its Role - The Unit is called the Prosthetics/Orthotics Research and Development Unit. Prosthetics is the field of artificial parts for the replacement of missing human parts. Orthotics is the field of mechanical bracing of disabled human parts. The Unit was established as an aftermath of the Thalidamide event in which mothers who took the drug Thalidamide, gave birth to deformed children. The Unit was established in the fall of 1963 and has been in existance for five years. The mandate to the Unit, as to the sister units in Montreal and Toronto, was to do research, development work and education for the improvement of the practice of prosthetics and orthotics in Canada. We are, therefore, task oriented and proceed on the basis of a broad solution of a human problem.

Lower extremity prosthetics for adults was selected as the first area for attention by the Winnipeg based Unit because:

1. Key staff members had the greatest degree of competence in this area.

2. The need was great because of the increasing incidence of amputation of the lower extremity, related to the aging of the population and the improved life saving techniques of medicine.

3. This area was receiving insufficient attention by other researchers and developers. Other researchers and developers were concentrating on upper extremity work related to children and we felt obliged to avoid duplication.

4. We felt that lower extremity bracing (orthotics) was also

a neglected area of work and recognized that our attention to lower extremity prosthetics would lead naturally into this field once the other area was sufficiently advanced to carry itself.

The Units Personnel

The Staff includes the following:

1. Dr. F. R. Tucker, M.Ch. Orth. (Liv.), F.R.C.S., (C. & Edin.), Medical Director, 5 years in the field)

2. Mr. J. Foort, MASc., (Chemical Engineering) Technical Director, (17 years in the field)

3. Mr. I. Cochrane, Engineering Technician (5 years)

4. Mr. D. Hobson, BSc., Mechanical Engineering, Design Engineer, (4 years)

5. Mr. R. Daher, BSc., Mechanical Engineering, Design Engineer, (1 year)

6. Mr. P. Nelson, MSc., Electrical Engineering, Research Engineer, (1 year)

7. Professor R. N. Scott, Consultant, (9 years)

8. Mrs. P. Armstrong, Secretary

PROGRAMME

(a) Development - It has been our main goal to design and develop a Modular System of prosthetics for the lower extremity so that rapid assembly and adjustment of prostheses for new amputees would be possible. This would eliminate delays and interruptions in their rehabilitation programmes so that rehabilitation would proceed more smoothly and efficiently.

(b) Production - We have successfully brought to development most of the components needed for the assembly of Modular prostheses for all levels of lower extremity amputees, except knee disarticulation and Symes (ankle disarticulation). Devices for these are also being designed and developed.

As an adjunct to the design and development work, we have had to establish production potential in the Winnipeg area so that the items designed can be produced for use across the nation. In the process of getting industry involved, we have contributed to the development of new capabilities and to the improvement of some existing ones in the industries co-operating with us.

Some items produced as a direct result of these efforts include:

1. SACH feet made of polyurethane foam
2. Cosmetic covers made of polyurethane foam
3. Prosthetic knee unit which includes rigid polyurethane section an extruded aluminum section and a pneumatic swing phase control cylinder
4. Wedge-disc alignment units made of aluminum
5. Cable Recovery Unit which takes up slack in prosthetic arm cables used to activate the arm joints.

(c) Testing - Over two hundred and fifty amputees are currently using the devices we have designed and nursed into production. Cost of this amputee testing is borne mostly by the amputees and interested agencies (Provincial, Municiple, Federal and private).

Others in other Canadian provinces and a few in other parts of the world are investigating our designs on their amputees. Those items which are now close to their final form are suitable for routine clinical use. The export potential is there, but the necessary publicity has not been carried out because of the newness of the designs and the need for a little more shake-down to permit manufactures to get into swing on the more difficult parts they make.

(d) Education - Educational work has been carried out in every province of Canada except New Foundland, Nova Scotia, Prince

Edward Island and Quebec. The Prairie provinces and parts of Ontario have been especially involved to our mutual benefit. Twenty-five technicians from these provinces have received training in modern techniques as well as training in the use of the Modular System we are developing. Three people from the United States have received training. Five Prosthetists with no previous training have been trained to full competence in lower extremity prosthetics.

(e) Staff Affiliations - Mr. Foort is Chairman of the Socket Design Work Panel of the Committee on Prosthetics Research and Development (C.P.R.D.), National Academy of Sciences, Washington, D. C. This involves chairing meetings twice a year, usually in the United States and attending other special meetings dealing with other aspects of prostheses design. He is also a member of the North American Sub-Committee of the International Committee on Prosthetics and Orthotics of the International Society for Rehabilitation of the Disabled.

Mr. Hobson is a member of the Orthotics Work Panel, (C.P.R.D.) and attends these meetings once or twice a year.

Dr. Tucker, Professor of Orthopaedic Surgery, University of Manitoba, is Chairman of the Medical Advisory Committee of the Canadian Rehabilitation Council, Past President of the Canadian Orthopaedic Surgeons Association. He is also a participant in the C.P.R.D. organization which deals with child prosthetic problems.

Professor Scott is a member of the Committee on Prosthetics Research and Development (C.P.R.D.).

(f) Co-operative Activities - Other Researchers

1. Bio-Engineering Institute, University of New Brunswick

(a) Development of an electronic alignment device for use in the aligning of lower extremity prostheses

(b) Development of electronic implants which could be used to control electrical prostheses

(c) Study of pre-tibial muscles of shank amputees to see if neutralizing muscles would lead to useful myo-electric control.

2. Ontario Crippled Children's Centre, Toronto, Ontario

(a) Development of cosmetic polyurethane foam covers for the Toronto Child's polycentric leg

(b) Field testing of some of their design items

3. Committee on Prosthetics Research and Development, Washington, D. C.

(a) Testing the air cusion socket designed at the University of California

(b) The Hosmer Knee Shank Unit with pneumatic swing phase control designed at the University of California

(c) The Northwestern University suspension casting technique

(d) The direct forming of sockets using polysar (Canadian product) developed by the Veterans Administration Prosthetic Centre, New York

(g) Publication, Reports and Theses

Published:

1. "INSTANT PROSTHESES" - Report No. 1, January 1964, by James Foort, MASc., P.O.R.D.U. Winnipeg, Manitoba

2. "PLASTIC LAMINATE WORK SPLINT FOR THE WRIST" - Report No. 2, July, 1964, by Ian Cochrane, P.O.R. D.U., Winnipeg, Manitoba

3. "WEDGE-DISC ALIGNMENT UNIT" - Report No. 3, December 1964, by D. A. Hobson, I. Cochrane, J. Foort, P.O.R.D.U., Winnipeg, Manitoba.

4. "OPPOSITION POST PROSTHESIS FOR TRANSMETACARPAL AMPUTEES" - Report No. 4, January 1965, by I. Cochrane, P.O.R.D.U., Winnipeg, Manitoba.

5. "SIMILARITIES OF THIGH STUMPS RELATED TO SOCKET DESIGN" - Report No. 5, by J. Foort, MASc., March 1965, P.O.R.D.U. Winnipeg Manitoba.

6. "A PYLON PROSTHESIS SYSTEM FOR SHANK (B/K) AMPUTEES" - Report No. 6, November 1965, by J. Foort, D. Hobson, P.O.R.D.U., Winnipeg, Manitoba.

7. "USE OF ELECTRONICS TO ALIGN THE BELOW-KNEE PYLON PROSTHESIS" - Report No. 7, January 1968, by W. Ivey, P.O.R.D.U. Winnipeg, Manitoba.

8. "INSTALLATION MANUAL FOR THE CABLE EXCURSION RECOVERY UNIT" - Report No. 8, July 1968, by I. Cochrane P.O.R.D.U. Winnipeg, Manitoba.

9. "AN ELECTRONIC AID FOR THE ALIGNMENT OF THE BELOW-KNEE PROSTHESIS - Thesis by Vaughn Dunfield, B.Sc. University of New Brunswick, Fredericton, N.B., 1967.

10. "IMPROVED PROSTHETIC DEVICES FOR THE LOWER LIMB AMPUTEE" - Thesis by D. A. Hobson, Spring 1965, P.O.R.D.U. Winnipeg, Manitoba.

11. "SOME PROBLEMS IN POWERED PROSTHETIC AND ORTHOPAEDIC APPLIANCES" - Thesis by William Ivey and Paul Thompson, Spring 1966, P.O.R.D.U. Winnipeg, Manitoba.

12. "THE PROSTHETIC AND ORTHOTIC RESEARCH AND DEVELOPMENT UNIT OF WINNIPEG: A REPORT ON ITS ACTIVITIES" - by F. R. Tucker, M.D., F. R. C. S. (Edin. and C), Medical Director, P.O.R.D.U., Winnipeg, Manitoba, Manitoba Medical Review, Volume 48, No. 2, February 1968.

13. "THE PATELLAR-TENDON-BEARING PROSTHESIS FOR BELOW-KNEE AMPUTEES - A REVIEW OF TECHNIQUE AND CRITERIA" - by James Foort, MASc. Artificial Limbs, Volume 9, Report No. 1, Spring 1965, P.O.R.D.U. Winnipeg, Manitoba.

14. "SURGICAL IMPLICATIONS OF MYO-ELECTRIC CONTROL" - by Dr. F. R. Tucker and Professor R. N. Scott, November 1968, Clinical Orthopaedics, Vol. 61, 248-260.

15. "DEVELOPMENT OF A SURGICALLY IMPLANTED MYO TELEMETRY CONTROL SYSTEM" - by Dr. F. R. Tucker and Professor R. N. Scott, November 1968, Bone Joint Surgery, 50-B, P. O. R. D. U., Winnipeg, Manitoba.

16. "MYO-ELECTRIC STUDIES ON THE TIBIALIS ANTERIOR MUSCLE IN BELOW KNEE AMPUTEES - by Dr. F. R. Tucker, J. Foort and W. Ivey, Canadian Journal of Surgery, P.O.R.D.U., Winnipeg, Manitoba.

Reports in Process:

1. Theses - Peter J. Nelson
2. Theses - Reinhart Daher
3. Above-Knee Manuel

Films:

1. In addition, a film for educational purposes, "THE ADJUSTABLE BRIM FITTING TECHNIQUE" by J. Foort was produced.

Partially Completed Film:

1. Lower Extremity Prosthetics

Slides:

1. There are over 1,200 slides accumulated on prosthetics for use in education.

Reports:

1. Progress reports have been issued bi-yearly, and recently, a summary report covering the past five years was issued December 31st, 1968.
2. The yearly grant from the Department of National Health and Welfare amounts to approximately $70,000 of well spent money.

APPENDIX 220

Brief submitted

by the Canadian Psychological Association

to the Special Committee on Science Policy of

the Senate of Canada

The brief which the Science Secretariat submitted to the Special Committee of the Senate (see minutes of the Committee, no. 23, p. 3397-3399) contains a summary of a study of Psychology in Canada carried out by the Canadian Psychological Association in 1966. The major findings of this study are still substantially valid to-day and necessarily form the basis for any discussions of policy in this branch of science.

While the report prepared for the Science Secretariat touches on a large variety of issues only those aspects which impinge on general questions of science policy will be further discussed here.

1. Psychological services are needed as much in Canada as they are in the USA. Yet two factors emerge quite clearly from the Science Secretariat's Special Study No. 3 (Psychology in Canada, Appley & Rickwood, 1967). We have only half as many psychologists in Canada (per capita) as they do, and the ones we have are less well qualified. While only 40% of psychologists in Canada hold the Ph.D. degree, the corresponding figure for the U.S. is 67%. In view of the serious human implications of much of the work done by psychologists the highest levels of professional training are desirable.

Our deficiency in psychology is not general. Psychology in Canada is strong and healthy in one area, and weak and retarded in all other areas. It has done relatively well in the established area of university based experimental research on such basic processes as memory, learning and brain function. In this area conditions in Canada are in no way inferior to those in the U.S. However, this is not true for research concerned with psychological development, personality, educational and social psychology. In these fields Canada has remained far behind the U.S. and some European countries. Also, there has been a regrettable lag in the application of psychological research to practical problems in industry, in education and in the area of community development. It must be a primary objective of policy in this area to build on what has already been achieved in basic research and to extend the scope of psychological research.

3. Psychology is strong in those areas that have benefitted from Federal support for the sciences; it is weak in those areas that have been left to the provinces. Because of the Federal-Provincial division of responsibilities certain areas of research fall between two stools and suffer neglect. This has been the case with research in the area of developmental psychology which is singularly ill-developed in Canada. Because education is a provincial responsibility

there exists no Federal research granting agency which will feel justified in making major grants in an area so closely related to education. On the other hand, provincial education authorities are understandably more concerned with immediate practical problems than with basic research on child development whose practical pay-off is likely to be one or two generations away. There is no reason to question the necessity, in Canada, of preserving provincial control over such matters as education. What is open to question, however, is whether research even in such areas must be left to starve under local control. It is the support of research in these areas that will rectify the present imbalance in Canadian psychology. And this will only happen if there are strong federal agencies capable of behaving as effectively and intelligently as NRC and DRB have done in giving direct support where it will do the most good. If psychology in Canada is to make its proper contribution to the nation's welfare, there must be a national science policy which provides federal leadership where it is most needed.

4. Over the last two or three decades there has taken place an extraordinary development of highly specialized techniques for the study of human behaviour. There has also accumulated a very large body of scientific data that is relevant to human problems in a variety of settings. However, there is a considerable lag in the assimilation of

this material by administrative agencies. It is often not realized by the non-specialist that a great deal of relevant information is contained in the existing scientific psychological literature, nor has he the training to utilize this information. It would be desirable to increase awareness of this problem among administrators and to aim for the involvement of experts in the field of behavioural science in projects that have a clearly defined human dimension. If psychological research in Canada is to move effectively into at least some of the areas that have been neglected hitherto, it is essential that the major granting agencies concerned establish advisory panels of individuals with appropriate training and experience in these fields. So far, only the National Research Council and the Defence Research Board have done this, a fact which is not unconnected with the far healthier state of those branches of psychological research for which NRC, in particular, has made itself responsible.

5. It is ironic that those fields of Psychology which have been relatively underdeveloped in Canada are precisely the fields in which it is not possible to rely completely on the results of research done in other countries. To the highly developed areas of physiological and experimental psychology it is a matter of indifference whether studies are conducted in laboratories situated in Montreal or in Boston or Tokyo. But where it is a matter of establishing

norms for the psychological development of children or of applying social psychological techniques to human problems in industrial or community settings, it is always necessary to do local research before the relevance of findings reported from other countries can be assessed. Present levels of excellence in experimental psychology need to be maintained to provide a basis for the training of psychology students in proper standards of scientific rigour. However, if the country is to obtain an appropriate benefit from the funds invested in psychological research it is necessary to give more encouragement to those areas of behavioural science which impinge more directly on human problems in a Canadian context.

Brief to the Special Committee on Science Policy from the Canadian Meteorological Society

1. SUMMARY

The Canadian Meteorological Society recommends that government support be given to or increased in:

1) the Global Atmospheric Research Programme (GARP);
2) applied meteorological research in the many problem areas that exist, such as air and water pollution, weather modification, resources, development, etc.;
3) the improvement of both the quality and quantity of meteorological observations;
4) the provision of increased meteorological counselling services;
5) encouraging all universities to offer additional courses in meteorology, especially in professional schools;
6) the improvement of basic meteorological education in elementary schools,
7) and that a Meteorological Bill be drafted to legislate responsibilities and authorities in meteorological matters across the nation.

2. METEOROLOGY IN CANADA

There is no part of the Canadian economy that is not influenced to some extent by weather, and few human activities in Canada escape the effects of weather. At the same time the level of exploitation of meteorological science by many sections of the economy, and the standard of knowledge of the subject by most citizens are both so low that productivity suffers. This Society* feels that increased attention to the science of meteorology by the Government of Canada would lead to marked economic and health benefits.

3. SCIENTIFIC ACTIVITY

Scientific activities as they pertain to meteorology in Canada in 1969 are shown in Table 1. Current activities in the four sub-groups have been noted as they are carried out by the four participating groups - Government (Federal and Provincial), universities, the

private sector and by societies. The discussion that follows consists primarily of suggestions and recommendations regarding increased and improved activities and is summarized in Table 2.

A - Research and Development

There is a need for increased attention to be given to both basic and applied meteorological research in Canada. The attention of the committee is drawn to the following published reports on this subject:

1) Physics in Canada, Survey and Outlook, Science Secretariat, Special Study No. 2. Section 5: Meteorology and the Atmospheric Environmental Sciences - Summary and Conclusions, p. 207.
2) A Major Program of Water Resources Research in Canada. Science Council of Canada, Report No. 3. Appendix 2, Categories and Topics of Water Resources Research, p. 33.

In addition, it is expected that the value of meteorological research has already been covered in briefs submitted to the committee by the Meteorological Branch and various universities. This Society strongly endorses government support for a national Canadian Global Atmospheric Research Programme (GARP), as well as for increased support for applied research in connection with water resources, air and water pollution, agriculture and forestry, the arctic, weather forecasting, etc.

B - Data Collection

This Society believes that the national meteorological service should be encouraged to improve the quality and quantity of meteorological observations in the settled areas of the country, especially in large urban areas, and to expand the very limited existing meteorological observing networks in and beyond the fringes of settlement, particularly into the Arctic.

C - Scientific Information

While improved weather forecasts, resulting from the recommended increased research and data collection activities noted above, would be of significant importance, it will only be through the complete intelligent utilization of meteorological data and advice that a maximum of potential economic benefits can be obtained from increased expenditures.

There exists in Canada today a pool of competent professional meteorologists. Most of these are employed in the national weather service, but six universities have professional meteorologists on staff, and others have physicists, agriculturalists, geographers, etc., who have more than a passing interest in, and knowledge of, the subject. Many of these people could be used to provide, or to teach others to provide, the consulting services needed to realize the goal of better meteorological services for Canadians.

Through cost-benefit studies it should be possible to make potential users of meteorological advice and information aware of the benefits that can accrue to them through using the advice of consulting meteorologists. Government departments are in a position to provide leadership to the private sector by engaging specialists to undertake studies of the broad impact of meteorology on different aspects of our economy, to examine all the scientific, economic and social impacts of weather modification, to study the effect on our environment of air and water pollution, etc. The carrying out of such environmental studies by government would do much to publicize the capabilities of applied meteorologists to commerce and industry.

D - Education

Educational activities in meteorology are currently being carried out by the national meteorological service and by universities and colleges. This Society recommends that the universities should be encouraged to offer additional courses in general meteorology for Arts and Science students, and at the same time significant meteorological content should be introduced into such professional courses as Engineering, Agriculture, Resources Management, etc. While there are currently three universities providing courses in Theoretical Meteorology, there is a marked need for professional courses at a French language university as well as for courses in Applied Meteorology to be taught in both languages at the post secondary school level.

It is noted that on elementary levels meteorology is one of the most poorly taught subjects in our schools. This is undoubtedly due to the lack of teacher training in meteorology and to the scarcity of

suitable texts. This is a field in which the national meteorological service and/or this Society could assist. ATMOSPHERE, a publication of this Society, would be an excellent vehicle for the provision of source material for the teachers of elementary meteorology. Also it would be possible for either the Meteorological Branch or this Society to establish a task force to develop educational materials and act as consultants to educational authorities. Participation by the Society in either scheme would require financial support.

There is at present no professional meteorological journal in Canada. While the need for such a journal has often been expressed, it is felt that it will only become a reality when the provision of government funds allows the National Research Council to add such a journal to those that it already publishes.

E - Regulatory

To the best of our knowledge, there is at present no specific statutory or other authority regarding meteorology in Canada. . The Society feels that it is now time for federal and provincial governments to confer and legislate regarding areas of responsibility and authority in the general meteorological field as it pertains to natural resources, pollution, weather modification, etc. Considerations could also be given to the establishment of professional standards to which professional consultants, professional societies, etc. would have to adhere.

Furthermore, it is suggested that primary responsibilities in many of these fields should be federal. This is because meteorology recognizes no political boundaries, and so uniform national standards should be established.

APPENDIX

The Canadian Meteorological Society - Société Météorologique du Canada is a national organization which exists for the advancement of meteorology. Local Centres in Vancouver, Edmonton, Regina, Winnipeg, Toronto, Ottawa, Montreal, Quebec and Halifax hold periodic scientific meetings. Annually a three-day National Meteorological Conference is held, primarily for the presentation of scientific papers and also for election of the National Executive, presentation of prizes and transaction of business.

The Society publishes the quarterly ATMOSPHERE, and the policy of its editorial board is to produce a periodical with appeal to all members. Membership is open to all interested in meteorology, and includes several Canadian names well known in international meteorology, as well as those of scientists, weather observers, technicians, amateurs and laymen. Current membership is about 575, and in addition, subscriptions to ATMOSPHERE are held by foreign institutions and individuals.

The ordinary membership fee for 1969 is $7.50, and student members pay $1.00. Subscriptions to ATMOSPHERE for schools are $2.50. Over three-quarters of the budget of the Society goes into the preparation and publication of ATMOSPHERE, and student memberships and school subscriptions do not cover costs.

The Canadian Meteorological Society,
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Toronto 1, Ontario.

The Council of the Canadian Meteorological Society for 1968-69 consists of the following:

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Vice-President:	Mr. J.P. Bruce, Canada Centre for Inland Waters
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This brief compiled on behalf of the Society by

Mr. M.K. Thomas, President, and Mr. J.A.W. McCulloch, Editor - ATMOSPHERE.

February 28/69

TABLE I

SCIENTIFIC ACTIVITIES - SITUATION IN 1969

Participating Groups	Research & Development	Data Collection	Scientific Information	Education
Government:	a) Basic research b) Applied research c) Development of instruments and methods	a) National observing networks b) Projects at research stations	Services a) Weather forecasts b) Climatological c) Advisory (Consulting) Support Services a) Libraries b) Instruments	a) Professional training b) Technical training
Universities:	a) Basic research b) Applied research	- -	Advisory (Consulting)	a) Professional b) General
Private Sector:	Applied research	- -	Advisory (Consulting)	- -
Societies:	- -	- -	Advisory Publications	

TABLE 2

SCIENTIFIC ACTIVITIES - RECOMMENDATIONS

	Research and Development	Data Collection	Scientific Information	Education	Regulatory
Government:	Canadian participation in the Global Atmospheric Research Program and increase in Applied Meteorology	More and better meteorological data, especially in urban areas, Subarctic and Arctic	More meteorological consultants both in and out of government	Better publications and assistance to educational systems	A Federal Meteorological Act
Universities:				More courses, especially in Applied Meteorology	
Private Sector:		- -		- -	
Societies:	- -	- -	- -	More publications and assistance in curriculum preparation	

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